FACTORY MANAGEMENT and MAINTENANCE

MARCH, 1933

It cost $30,000 to move, but—

We'll SAVE *$125,000!*

*Franklin H. Fowler and W. A. Barr**

General Manager *Manager of Manufacturing*
Foote Brothers Gear & Machine Company, Chicago

HOW A company abandoned a 5-story plant, consolidated its manufacturing in one modern unit, and is now able to operate at a profit on one-eighth the old volume. Every detail, from power wiring to actual transfer of equipment, was so carefully planned that machine tools were dropped into place, and within two hours were ready to pick up right where they left off

IN A BUSINESS which grows fast, development is likely to be piecemeal rather than planned. When we came to estimate the economy that would result from consolidating our two Chicago plants, scrapping the obsolete machinery and rearranging the rest for more economical processing, the saving promised to be large enough to pay for itself in a few months of operation. This saving has now been realized.

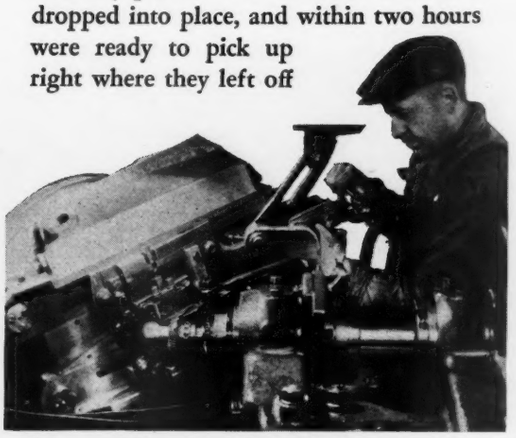
Our Curtis Street plant, in which business had been carried on for many years, was ill adapted to economical manufacturing. It was a 5-story plant in which there were no less than 18 floor levels, and the whole manufacturing space was cut up by brick walls and partitions.

We had acquired a second plant, our Plamondon unit, a modern building with 60,000 sq.ft. of floor space, well constructed and laid out, containing many fine new pieces of equipment. This plant, in which we have been producing heavier gears, included a foundry and machine shop. It was decided to discontinue the foundry and buy castings, which could be produced cheaper and better by specialists. Obsolete machinery in both plants was to be sold, and the equipment, including many machines of recent purchase of the most modern type, from our Curtis Street plant was to be combined with that in the Plamondon unit in a more compact and economical layout.

Work was started September 6, 1932. About 25 days were spent by our engineers in planning. The new layout was in full operation within 10 working days from the start of actual moving. The entire planning and moving of materials and equipment worth about $2,500,000, took 35 days and cost about $30,000.

Planning started with layout. A floor plan of the Plamondon plant, to a scale of ½ in. to the foot, was laid out on a big 12-ft. table. Templets, to the same scale, were cut to represent each machine to be moved. These templets were detailed to show location and size of pulleys, power take-off, whether in back or in front, maximum travel of working parts or stock, position of the operator and so on.

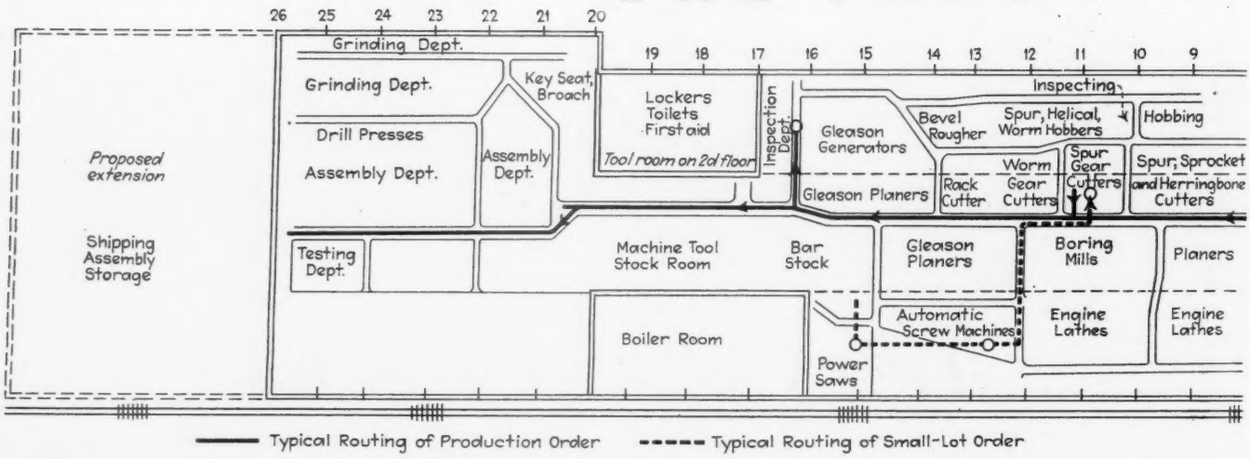
In placing the machines, special attention was given to convenience for handling material, close grouping to permit one man to operate as many as possible and to cen-



By consolidating the two plants, we got rid of obsolete machinery and kept only the most modern and accurate production equipment.

**As told to H. P. Dutton.*

THE PLAN . . .



tralize operations of like kind wherever it proved feasible.

Convenience in handling materials dictated the general layout shown in Figure 1. Production jobs, for which we normally receive materials from the vendor rather than from raw stock, go direct from the receiving room to the semi-automatic and other production lathes, then across the aisle to the gear shapers, thence to inspection and shipping.

Small orders for from 1 to 12 pieces are usually cut from blanks carried in stock. The screw machines and engine lathes normally used for this work are placed next to the storeroom, with the more specialized types of gear cutters and planers directly opposite. Heavy machines, including large boring mills and gear cutters, are located in the center bays, where they can be served by overhead cranes. The general flow of work is almost without reverse movement. The number of men required for handling materials was reduced from 12 or more to 3.

Close grouping of machines also made substantial savings in man power. One man is operating two or three turret lathes where he ran one before, six to seven shapers to three before, and so on. Thus the closer layout necessitated by the reduction in floor space was made a virtue.

Only the barest necessary provision was made for stock, either raw, finished or in-process. As to in-process stock, we believe there should never be any occasion for more than two or three jobs at a machine; with more than that, not only is inventory increased but there is danger of delays on some orders.

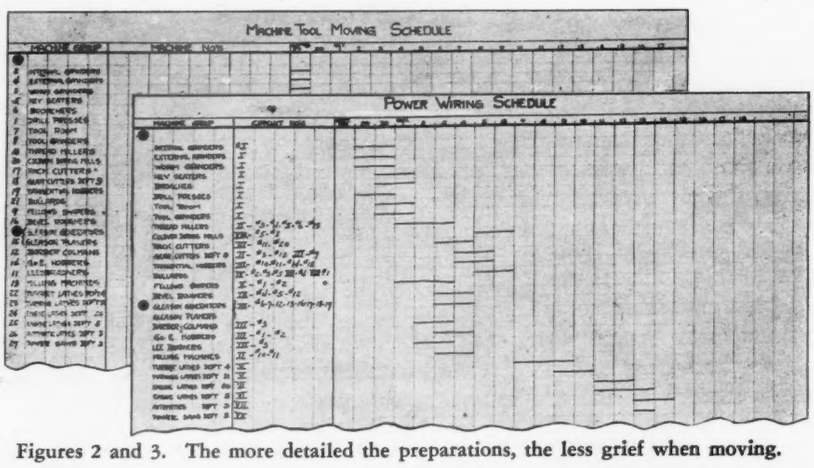
Under present conditions, a small, carefully selected and controlled stock of gear blanks enables us to fill all urgent orders at once. Finished stock, with few exceptions, is shipped as soon as completed. Should changed conditions necessitate further provision for storage, it will be provided in another building. We want to keep stock moving fast, once it enters manufacturing, and believe one way to do it is to provide no space where it can loaf. We are now turning stock four times a year.

Much more space is required for the storage of our extensive stock of tools, special cutters, patterns and fixtures than for materials. The central toolroom, which replaces with considerable economy the former collection of departmental toolrooms, is located near the center of the shop, convenient to all departments.

Centralizing operations and bringing together machinery of like types, the third point considered in making the layout, resulted in improved supervision and made for the most economical operation and power connection.

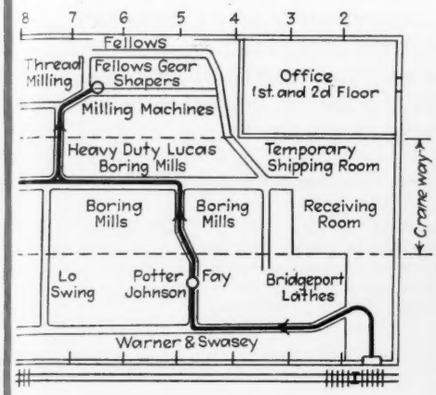
Making the layout required close and constant consultation between engineers and foremen. When it was completed, the next step was to plan the power transmission. Speeds of lineshafts had to be figured at mean speeds in relation to the equipment driven, so that the required machine speeds could be obtained with permissible pulley ratios. Countershafts were arranged to correspond with the machine layout decided upon, or the latter was shifted in detail where necessary. Motor positions and sizes were determined, and a detailed list of motors was made up, including those on hand and to be purchased.

The next step was to prepare wiring diagrams. The shop was divided into circuits, which were numbered and arranged to correspond with the order of installation of



Figures 2 and 3. The more detailed the preparations, the less grief when moving.

. . . *and* THE PLANT



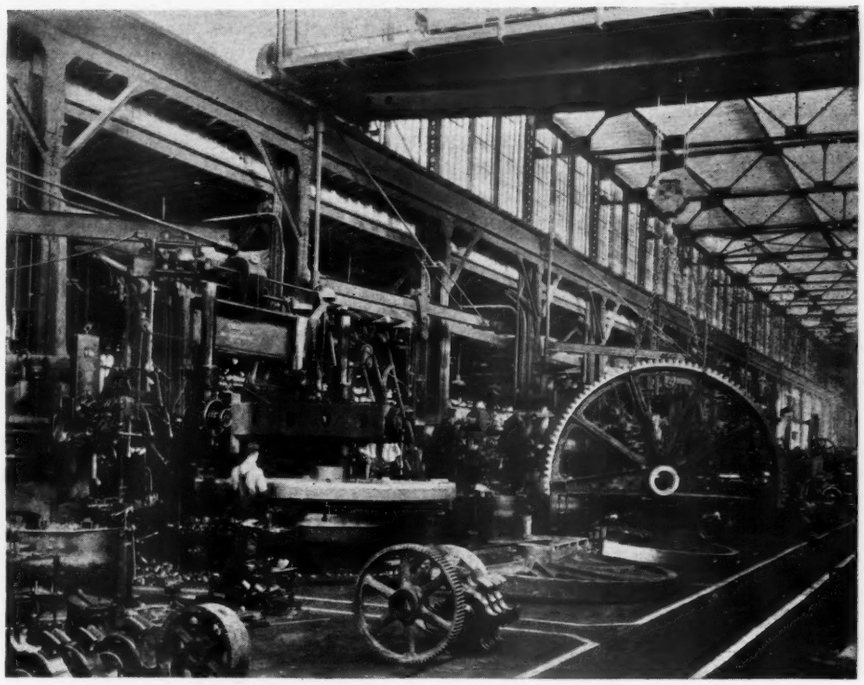


Figure 1. *(Left)* **The new layout—first step in planning the consolidation. In placing machines, special attention was given to the convenience with which materials could be handled. Machines were grouped so that one man now operates two or three turret lathes where he ran one before, or six or seven shapers where formerly he could handle only three. Also, meager provision was made for stock, either raw, finished or in-process. The management is convinced that there is no excuse for having more than two or three jobs at a machine. If there are more, up goes the inventory and the danger of keeping customers waiting.** *(Above)* **A view of the new plant.**

the machinery. A detailed wiring plan of each circuit was made, showing location of all motors and outlets, size of wire and other details. A time schedule (Figure 2) was also prepared.

A 440-volt circuit replaced the former 220-volt connections. Because of the heavier power load put on the circuit by the addition of the machinery from the Curtis Street plant, the existing wiring would have been insufficient. The new layout uses 80 per cent of the combined power of the two old plants. By doubling the voltage, and reconnecting the alternating current motors in the Plamondon plant to correspond, we were able to use the existing wiring, at a net saving of over $10,000. The Curtis Street plant was in a direct-current district, so all the motors in this plant had to be replaced anyway.

We were now ready to plan the actual move. A detailed schedule (Figure 3) was made up showing on what date each piece of equipment was to be in place. The working force was divided into two crews, one for production, the other for moving. All obsolete machinery was removed and auctioned off or put under the ball and smashed. We sold no specialized gear-cutting machinery, as we considered it to nobody's interest to start inexperienced competitors in business with low-cost but obsolete equipment. Only strictly general-purpose machinery, which might serve some other industry where it would not serve ours, was sold.

The installation of shafting and wiring was started and kept ahead of the movement of machinery so that when a machine was put in place, all that was necessary was to connect up the belt and turn on the power. Those machines which were needed for immediate production were running within two hours of their receipt.

Except for a few machines left in the Curtis Street plant to finish certain jobs, the installation started with the equipment used in the finishing processes and ended with the lathes and originating processes. This meant that production orders in both plants were started as usual at machines not yet moved, carried up to the point to which moving had proceeded, then moved to the corresponding point in the new layout and finished and shipped from the Plamondon plant. There was a certain amount of back-tracking, but only one order was delayed, and that only for two days.

One of the intangible but important savings was the breaking down of the isolation between departments, caused by the difference in floor levels and the walling-in of departments in the old plant. When a man has to climb steps, he probably does not get out of his department one-fourth as often as he should. He sees little of what happens to the product after it leaves his department, and he gradually sets up his own arbitrary rules as to how his work should be done. For example, if the turning department was making up an order of gears to be hardened, they were apt to say mentally if not actually:

"You don't need to tell *us* how much stock to allow for grinding. We've been figuring that out by perfectly good rules for 20 years."

In consequence, every so often a lot would come through hardening with insufficient grinding allowances. When many of your men have been in the same department for 20 years—and the average man has been with the company 10 years or better—this isolation becomes

a serious matter. Control can be secured only by rigidly specifying every detail and leaving nothing to custom and experience, a costly procedure with a great varity of work. Putting all operations on one level on an open floor encourages a natural communication and contact between departments, and secures the required coordination with much less supervision and friction.

Along with these major changes many secondary improvements were made. Inspection now heads up under one man, the chief engineer and manager of manufacturing, who by virtue of his position is in closer contact with the customer's needs than the operating departments, which probably have the least contact with the user of the product. A system of central production control, already in use in the Curtis Street plant, was extended to cover the entire force, with a saving of thirteen timekeepers. Organization lines were gone over, and responsibilities for manufacturing, selling, and financial and accounting control were more clearly and definitely centralized.

Of the plans shown in Figure 1, all are in present successful operation except the placing of the shipping department, shown by dotted lines. Steel framework and overhead crane which formerly served the foundry flask yard, are all in position for an addition to the building, so that only walls and roof need be added. This space will serve when completed as additional assembly floor and for shipping. Until then, orders ready for shipment are picked up by the crane and carried back to a temporary shipping room at the other end of the building.

The net effect of the various economies effected is to permit us to operate at a profit on one-eighth of the volume formerly required.

The annual savings from the move are estimated to be roughly as follows:

Rental, Curtis Street building	$50,000
Power (saving due to consolidation of two demand charges; will increase with heavier load)	8,000
Direct labor, heating, insurance, duplication of clerical and supervisory staffs, telephone, cartage, etc.	67,000
Approximate total saving per year	$125,000

In conclusion, our experience in moving indicates that the longer and more detailed the preparations for moving, the shorter, simpler and more trouble-free the move. If the planning is sufficiently careful, the move can be made the occasion for rectifying many of the faults of arrangement, equipment and organization which accumulate because it is difficult to change them without disturbing other activities.

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Management *DOES* Something About the Weather

Lewis K. Urquhart
Associate Editor

SOMEWHERE in the opening paragraph of this story belong Albert Gold and Emilio Rivas, cigar makers. They belong because it is to them and their years of cigar making that Henry Clay and Bock & Co. Ltd. is entrusting the management and quality control of the Trenton, N. J., plant in which cigars like La Coronas and a dozen other brands known to smokers of good cigars will be rolled from now on. Theirs is the responsibility for turning out a better cigar at lower cost than was ever possible as long as rolling operations remained in Havana.

Forty years or so, man and boy, cloak Albert Gold's and Emilio Rivas's pronouncements on cigars and cigar making with a shade more than the mere semblance of authority.

They have been through the mill. They were making good cigars back in the days when Mark Twain said in all truthfulness that everyone complained about the weather, but no one did anything about it. Here they are making better cigars today when management *can* do something about the weather and, in a growing number of industries, most decidedly *is* doing something about it. They, if anyone, should be able to tell us whether it would have been possible to transfer the rolling activities from Cuba to Jersey without the benefit of controlled weather conditions.

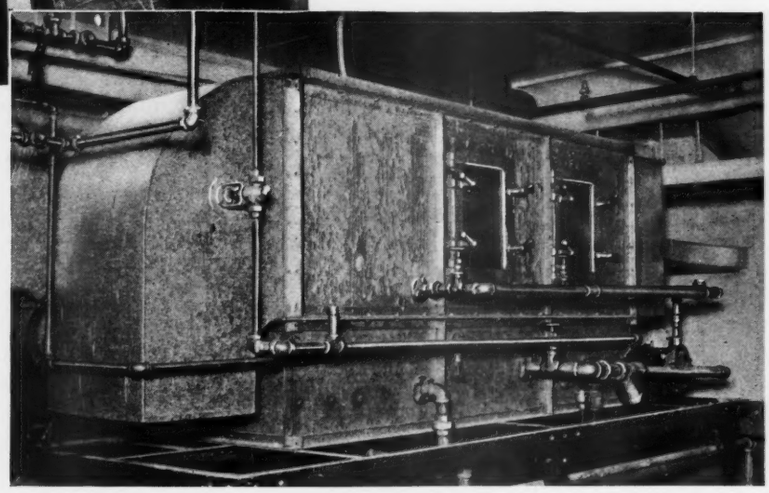
Albert Gold and Emilio Rivas say "No!"

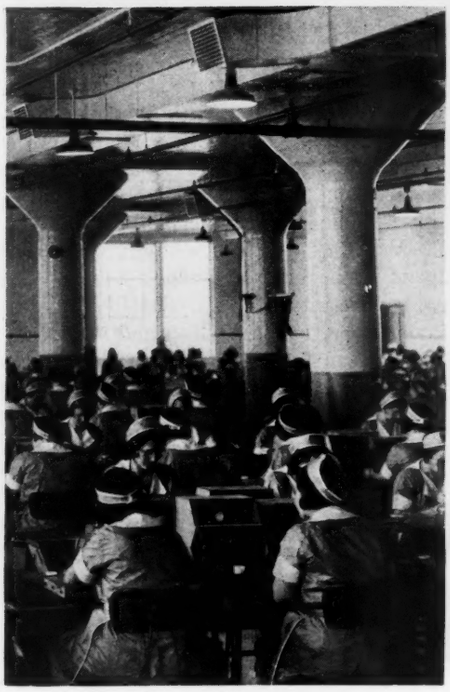
That "no" is here recorded for the special enlightenment of plant executives—and their number is many—whose processes and products are sensitive to the uncertain doings of the weather. That "no" is evidence of the reliance which management is learning to place in the comparatively new science of air conditioning.

With complete assurance, then, that Havana weather could be simulated in Trenton, Henry Clay and Bock & Co. Ltd. proceeded last fall to build a $500,000 plant that would house some 1,300 employees—a plant which, still in the making, had to be added to—a plant which when finished this very month will have 2,000 workers and can turn out 60,000,000 hand-rolled cigars a year—a plant in which manufacturing began just four days before the material for this article was gathered.

Somewhere back of this willingness to invest half a million dollars in a new factory may be seen the desire to give the man who knows good cigars and smokes them a better cigar at lower cost. There is nothing unusual in that desire. Substitute for the cigar smoker and his cigar any consumer and any product you like, and you have the motive which is uppermost in every manufacturer's mind. How completely this cigar concern succeeded in getting what it went after, may be illustrated by citing a single item out of its long line. Take its Corona Corona—which is to say the corona size in its La Corona brand. For years this famous cigar has retailed for 60 cents. Now you get three for a dollar! And that is almost exactly 50 per cent off the old price.

How is this reduction possible? First and foremost because the company is today paying a 10 per cent duty on cured leaf tobacco only—and that is a long way from the 100 per cent, or nearly that much, which it had been paying on finished cigars. Because, second, the internal revenue tax is based on retail price and is consequently half what it used to be. Because, third, Trenton girls have taken the place of the Havana piecework-





Above. **The first step in processing the wrapper. In the background, upper center, is the delivery end of the system that supplies washed, humidified, and heated air to this conditioning vault.**

Just below. **Conditioning unit that serves the vault above and two others exactly like it—one of five units all told which made it practicable to transfer rolling operations from Cuba to New Jersey.**

Left. **One of three rolling rooms now in operation, where Trenton girls in blue and white smocks roll better cigars than the company was ever able to produce in Havana. Coronas and other well-known brands of this concern's are now retailing at approximately half the old prices.**

ers. Not too fast, however. The saving here is not what you think it is. You could count on the fingers of both hands the direct-labor dollars that are saved today in the making of a thousand Corona Coronas. The real saving is due to nothing more nor less than the fact that those Havana pieceworkers were men. Trenton girls don't smoke cigars, but Cuban workmen do—in this instance, *did*—to the extent of eight or ten or twelve a day. Let's say 10 cigars a day. Multiply 10 cigars by 1,500 men—if a man didn't smoke, you may be sure his friends and relations did—and figure on 300 working days. No, you have made no mistake. The answer is 4,500,000 cigars a year! The company's estimate that this old Cuban custom was costing $250,000 annually seems a moderate one.

To these practical considerations, then, add last of all the regularity of production in an American factory with humidity and temperature control as against the uncertainties of Cuban labor, and you have a quite good picture of the ways and means that have made possible a reduction of approximately half in the retail prices of this company's products.

Trenton girls don't smoke cigars. Havana workmen did—eight or ten or twelve a day. The company estimates an annual saving of $250,000 from this source alone. Girls work in threes, the bunchmaker in the middle keeping two rollers busy.

It could not have been done without modern air conditioning. At least it could not have been done with any assurance that La Coronas and all the other company brands would measure up to long-time standards of quality. You and you and you, who smoke cigars, would not have been so certain of finding every Corona Corona like every other. To work properly, tobacco must be just right. If it is too dry, it will crumble and break—if too wet, it will mould. It is only by scientific conditioning that the cigar manufacturer can be sure of his product.

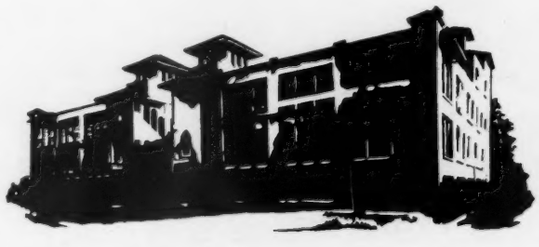
In this new rolling plant five conditioning units give assurance that the tobacco will be "just right." Two small ones supply air of proper temperature and moisture content to the rooms in which the filler is conditioned. A third unit serves three chambers in which the wrappers are processed. And two more units take care of the rolling operations, delivering fresh or recirculated air—or a mixture of the two—that has been washed and then humidified as conditions demand it. All this is done under exact control from the time the bales of tobacco leave the bonded warehouse in the basement until the finished cigars are banded and boxed, ready to leave the factory.

It would be taking unnecessary chances with the truth if we were to state that the quality of the cigar depends on conditioning alone, but it is fair to say that this same conditioning turns a delicately sensitive raw material into one that approaches standardization. And it is entirely accurate to say that the tobacco would not be uniformly workable without conditioning and there could be no real assurance of finally getting a quality product.

To understand, however, why every cigar of a given brand is like every other cigar of that brand—or as nearly like it as possible when working with nature's own raw materials—we must go back of this Trenton rolling plant. We must go back to the planting, cultivating, ripening, and curing of the tobacco. We must not for one minute overlook Emilio Rivas's careful selection and skilled blending which gives to each brand a flavor all its own. And, not least important, we dare not pass lightly over the skilled fingers which Albert Gold and his supervisors have trained. The preparation of the tobacco is in no wise changed. It is still done in Cuba. Blending, too, is still done under the same experienced direction. As for the skilled fingers, they were skilled long before Henry Clay and Bock & Co. Ltd. picked up these rolling activities and set them down in their new habitat.

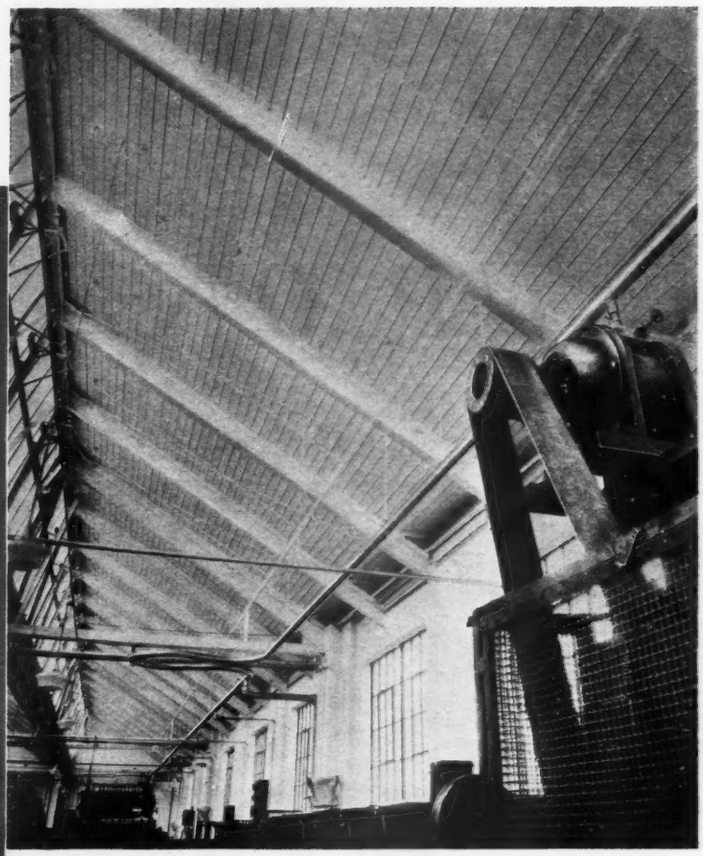
Ask these girls how long they have been rolling cigars. You learn that by and large they have grown up with the present supervisory force in another of the company's plants. They learned to roll cigars from the same supervisors who are teaching them today—from supervisors who can sit down, any one of them, and show them how. In this plant there is constant supervision and plenty of it. It is plain that good rolling means good training under good supervision. It is because of this training that the company is today producing better cigars than it ever produced before the move to Trenton, just as it is true that the simulated Havana climate is offering a regularity of processing and working conditions never before possible.

Notes on the building . . . U-shaped and Spanish and built around a patio, all in keeping with the character of the products being made in it . . . A daylight plant with plenty of natural light and enough artificial to supplement it when needed . . . Ceilings are white and have a high light-reflection value. Sprinkler pipes red against the white. Walls white, too, with gray dado. Against this background the blue and white smocks of the girls . . . A pleasant cafeteria, not too fancy . . . All in all, a factory that looks lean and stripped for action, a factory that can "stand and take it."

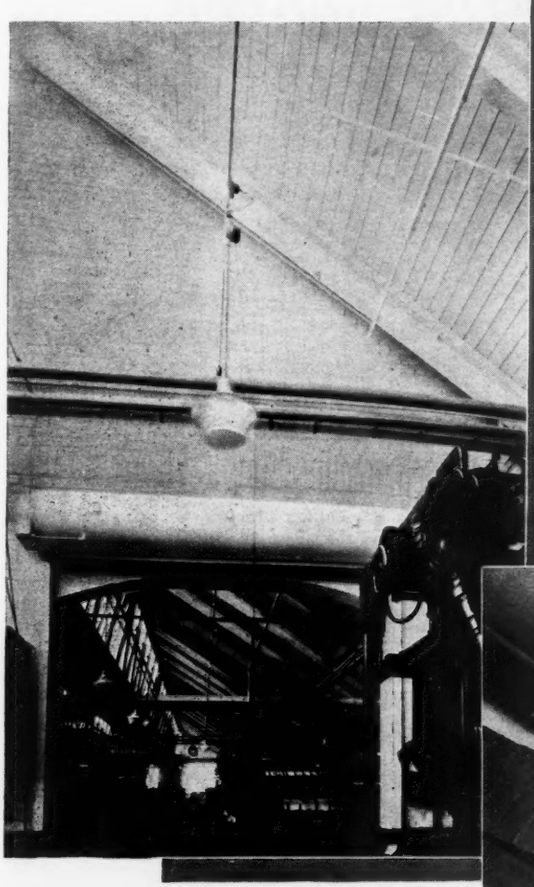


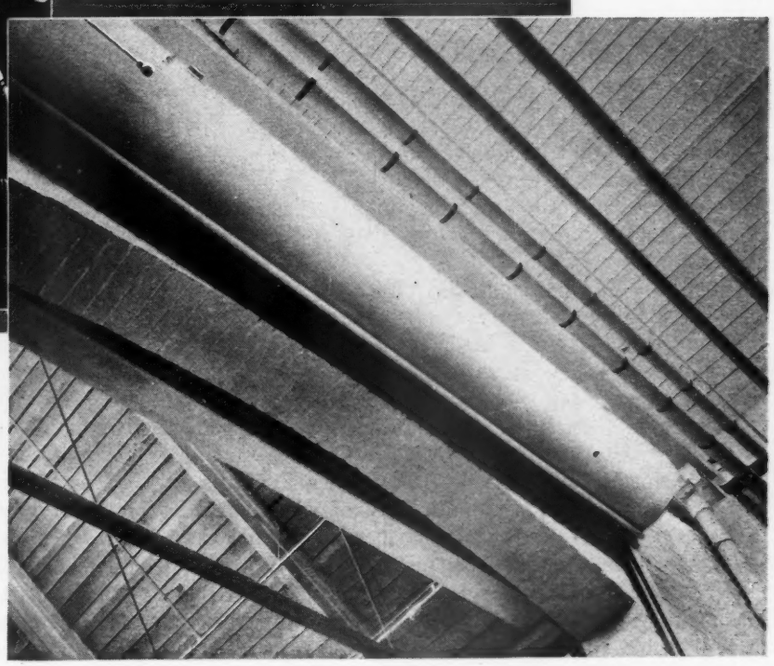
A WHITE *Plant's a* LIGHT *Plant*

If you are weary of being told about the reflection values of this paint and that—or aren't quite convinced that paint pays—cast your jaundiced eye upon these white interiors Rittase took at the Chilton Publishing Company in Philadelphia. Don't they tell the whole story of what paint can do for *you* in *your* plant?



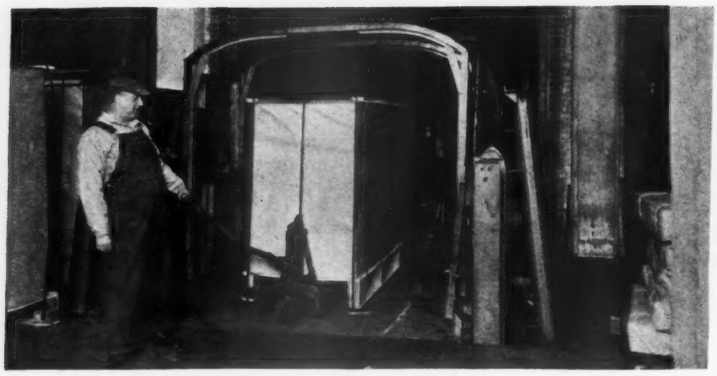
Halftones do scant justice to this white plant. Its walls and ceilings aid greatly in distributing the plenitude of daylight that comes in through skylighting and windows.





Dirt cannot hide in the white plant. And there is no place for dirt in the printshop—or in any other shop, if you please.

Lower left, white paint that's two years old and still good. Upper right, new white paint that's still better.



UP ONE...

on the tiering machine

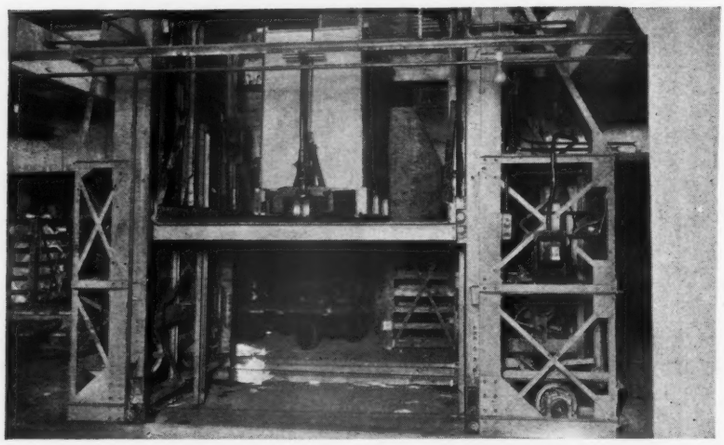


Figure 1—GOING UP!—from the basement to the first floor. This telescoping elevator solved the problem of keeping the first floor clear. It is rated 7,500 lb. and the 7½-hp. motor gives a platform speed of 15 ft. a minute up and down. Push buttons control operation.

L. B. Murdock

Chicago

TRANSPORTATION of materials between operations and about the plant involves many varied problems. If those involved in horizontal transportation are sometimes very perplexing, vertical handling presents angles that are even more puzzling.

Whether it is a matter of handling material from one floor level to the next, from the floor to a mezzanine, or just to and from a loading platform, proper and economical operation must be insured. First of all, a centrally located spot should be selected for the handling equipment, in order to expedite movement of the product and save footsteps.

Requirements vary widely. Sometimes a means of elevating and lowering a multiplicity of small parts or packages at a high rate of speed is needed. Other cases necessitate a large, heavy machine capable of handling larger, heavier objects at a lower speed. For these reasons the tiering machine, for years known exclusively as a portable stacking device, is becoming increasingly popular. Its adaptability to such work lies in the wide range of heights, types, and capacities in which it is available, and in the fact that it can be installed readily with little or no alteration to the building. Necessity of locating machinery and controls overhead is avoided with this equipment, since all the hoisting apparatus is located in the base.

In one instance handling of freight was required between the basement and first-floor levels of a building where it would have been expensive and impracticable to locate any part of the mechanism on the floor above. It was also desired to have the first floor free from all obstructions when the elevator was not in use.

The telescoping elevator shown in Figure 1 was built to meet these requirements. As the platform raises and lowers, the steel loop above it opens and closes the trapdoor in the first floor. Only when the platform is raised can any part of the lift be seen from the first-floor level. The lift is capable of raising material several feet above the first floor when serving motor trucks. Since it was

necessary to locate the elevator several feet from the outside wall, a hinged apron of heavy steel is attached to one side of the elevating surface to bridge the space to the motor truck.

A pit only 9 in. deep in the basement floor permits lowering the platform flush with that level, where automatic limit switches cause it to stop.

When lifting from one floor to the floor above, the telescoping principle used in this elevator is a decided advantage in that it leaves no opening in the floor above. Where this point is not important and the material to be lifted is lighter and less bulky, a simpler design of cantilever machine can be used. With the model shown in Figure 2 the only preparation necessary is cutting the opening in the upper floor, the dimensions of which need be only a few inches larger than the elevating platform. A pit 6 in. deep would enable the platform to be lowered flush with the lower floor. In this instance it was an advantage to have it stop at that distance above the floor. The upright frame projects approximately 3 ft. beyond the surface of the floor above; the opening is guarded by a folding rail similar to that used at the lower level.

Figure 3 shows how the problem of serving a storage balcony was solved with a machine of similar construction, although the more bulky nature of the merchandise handled required a somewhat larger platform. This outfit is equipped with small wheels and can in an emergency be moved about the plant to do any miscellaneous piling, lifting, or general millwright work.

Many plants that are located on the ground level have the problem of moving material to and from the loading platform. Ramps are sometimes used to make up the difference in levels, but such inclines are dangerous both to the merchandise and the workmen. They also tie up much valuable floor space if the pitch is slight enough to provide any advantage.

Here, again, the stationary-type tiering machine seems to offer the best way out. As a typical installation of this nature Figure 4 shows a 1-ton electric lift raising barrels to the shipping platform level for loading into freight cars. The platform of the lift lowers flush with the floor and is controlled by the cable control located on the near side of the upright frame. One man now handles the barrels easily and quickly, whereas previously loading a car was a hazardous, back-straining job for three or four men.

The frame of the machine was made considerably higher than is necessary for this operation, because later on a balcony which will be built to cover the area in the foreground will be served by it. The over-all height of the elevator is 13 ft., giving a possible lift of 8 ft. 9 in. above the floor.

Aside from obvious economies resulting from these adaptations of the tiering machine, there are intangible benefits such as better morale, fewer lost-time accidents, and pride in workmanship, which generally follow the installation of better handling equipment and do much to widen the profit margin.

Figure 2—Installation of a tiering machine for stationary service is mostly a matter of cutting a hole in the floor above and connecting the machine to the power lines. The one shown here can handle loads up to 1,500 lb. The difference between down and up is less than 30 seconds.

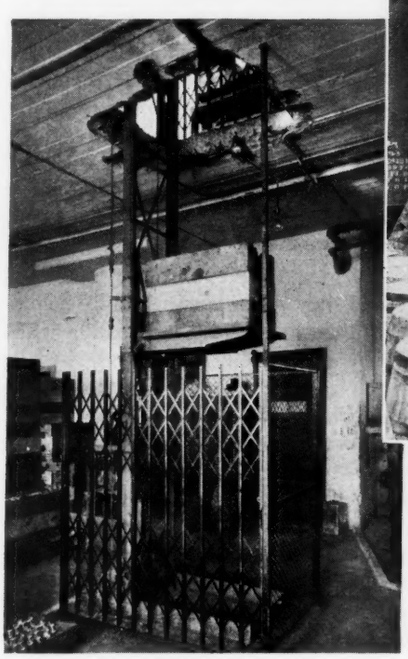


Figure 3—Looks like a permanent installation, but isn't. Most of the time this tiering machine handles packages to and from the storage balcony. When needed elsewhere by the maintenance department it can be taken out of its cage and rolled on its own wheels to any part of the plant.

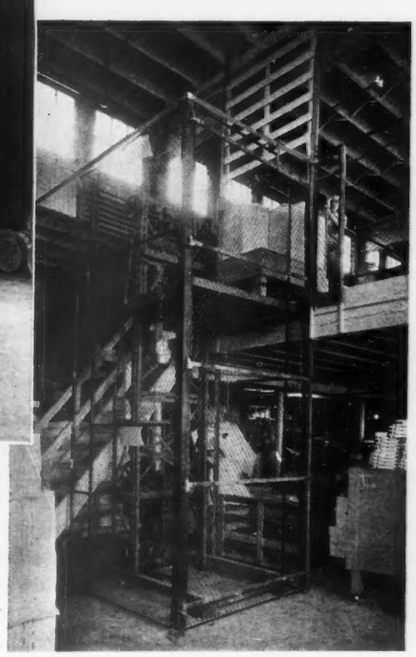


Figure 4—From floor to platform, three at a time. One man loads a car. It used to take three or four men. The machine is high enough to serve a balcony that will be built by and by

Lubrication Bills Too High?

Goodrich engineers cut theirs 67%

John W. Shaver

Cleveland

IF WE were to select a single maxim from among the guiding principles upon which lubrication engineering —for it is just that—at the plant of The B. F. Goodrich Rubber Company rests, it would be: "A burned-out bearing is a disgrace to the maintenance department." Upon that phrase has been built a plan whose execution since 1920 has resulted in a decrease of 67 per cent in lubrication expense per 1,000 lb. of raw rubber-processed.

Goodrich engineers believe that keeping machines lubricated is a science. If it is a science, it cannot lack the proper organization so that both the credit and blame will find their proper roosts. With this viewpoint, lubrication becomes a distinctly separate maintenance function. It is on a parity with pressure-vessel inspection, carpenter shop and pattern making, and mechanical maintenance. While it is in charge of a general foreman of lubrication, its functions are not entirely those of keeping machines oiled and greased. There is a development department where oil and grease are forever being tested and compounded, so that the best lubricant for each bearing may be secured. From these laboratory tests come specifications which go to suppliers and control all purchases of lubricants.

The actual business of oiling and greasing machines is done by three groups—one for each eight-hour shift. The first shift has a leader and five oilers; the second (day) shift uses a leader and sixteen oilers; and the third, or afternoon shift, has a leader and ten oilers.

That systematic plan has not always been in effect. In fact, the present set-up is but four years old, dating from the time that lubrication became a distinct maintenance function. However, careful records had been kept since 1920, so that total costs of materials and labor were available. Prior to about 1916 the cost of lubrication had been a rather haphazard charge against general engineering overhead, with production and repair men often doing what oiling and greasing was necessary. No one knew exactly how much oil and grease was being used, and lubricants were used without regard for quantity or quality, being simply classified as engine oil, cylinder oil, and gear and cup grease. Whenever a bearing needed lubricating, the handiest oil was the one used. *Oil was all too often getting on the product as well as on the floor.*

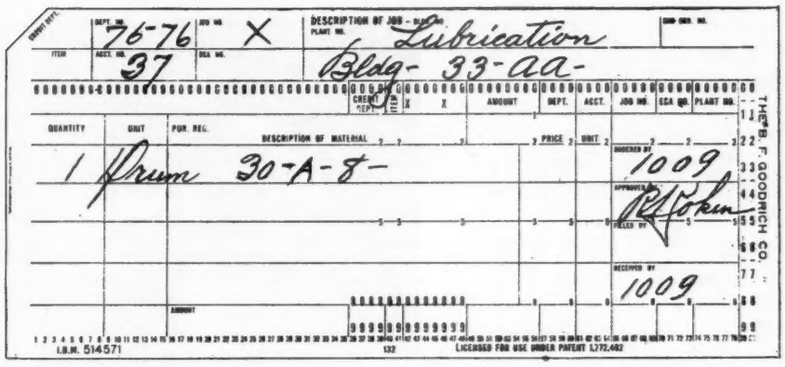
A BURNT-OUT bearing is a disgrace at Goodrich, where 34 men on an incentive wage are doing more work than 120 men did a dozen years ago. You may not have 130,000 bearings in your plant. You may not use 100 tons of grease a year, or 67,000 gallons of oil. But you *can* take a page out of this company's notebook and make sure you're getting systematic lubrication at something like reasonable cost

A drop of oil on rubber may go undetected until the product reaches the consumer—but it will send that product back to you. The Goodrich problem is just enough, never too much, lubricant.

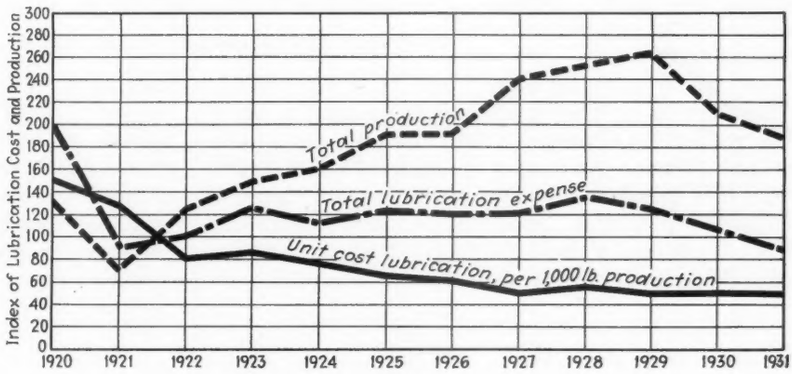
Something had to be done. The first thing was to organize a separate division under a lubrication foreman. Particular needs of individual bearings and gears were studied. A definite trend toward the replacement of oil by grease began. Various lubricants were tried out on troublesome bearings until the best one was found. Definite records were kept, and the production departments were told the amounts they were using and being charged for. Finally, the whole factory was studied with a view to assigning to oilers definite territories to be covered or work to be done. The lubrication foreman made such assignments at first. Naturally it was a cut-and-try method—which, however, worked as well as any such method might. The need for further economy led to time studies of every part of an oiler's job—how long it took to get his equipment ready, how long to fill grease cups of various sizes, how long to walk between machines, how long to lubricate a machine equipped with a pressure system, how much time

was required in climbing complex machines whose bearings or gears could not be reached from the floor.

The point system of wage payment is followed. Oilers have regular routes, whose lengths depend upon the frequency with which machines must be oiled. The day shift requires the greatest number of men, for the simple reason that more production machinery is then in operation. Through time studies and experience with lubricating the machines, an arbitrary number of points is assigned to each route. This number may be 500 for one route or it may be 750 for another. It represents good, average performance for the particular route covered. If a man works eight hours, for instance, he is guaranteed 480 points, which represents base pay. If a man is a good "squirrel" oiler, and can get around on machinery easily, he may greatly exceed this base. Thirty-three per cent above base is what each oiler aims to make. If he is exceptionally good, he may be given a longer route. This naturally would lead to a complete rearrangement of routes so that fewer oilers would be needed—which, in fact, is what has happened to reduce the previous force to its present efficient size. Incidentally, the present force of 34 men does more work—the factory has grown and production has been stepped up—than 120 men did during the 1916-1919 war period.



Lubricants are ordered by code. It's easier and keeps the supplier's name out of the shop. This requisition is punched and run through a tabulating machine. Frequent checks can thus be made on every lubricant used.



Lubrication engineering did this to Goodrich costs.

The organization is now set up. You know what you are going to pay to have the work done. You know what zones each man is to cover in each of the three shifts. But you still do not have lubrication.

In manufacturing rubber products, lubrication becomes even more of a problem than in most industries. It is not enough to remember that burned-out bearings are disgraceful. You must remember that a drop of oil anywhere on rubber may go undetected until the product gets to the consumer, but it will send that product back to you. This has led to making as many bearings as possible grease-lubricated. Approximately 85 per cent of all places where lubrication is required now use grease, including not only 130,000 bearings, but 3,950 open gears, 4,800 motors and 1,500 chain hoists. Some of them run in water, some near steam, some in dust-laden air, some in extreme heat and some in extreme cold.

The danger of spoilage and the desire to decrease lubrication cost led to a number of changes. In the change-over to grease, for instance, oil cups on the rubber mills were taken off, the holes were plugged and the grease cavities alone were used. If the machines had no grease cavities, slots were cut in the housings, and grease boxes were fixed over them. Grease cavities and boxes hold from 4 to 6 lb. each, and require filling only every four or five days. Oil cups had required filling every five or six hours. And they wore out often. So the cost of cups was saved, and two men are able to service 50 mills, whereas six were needed when oil was used.

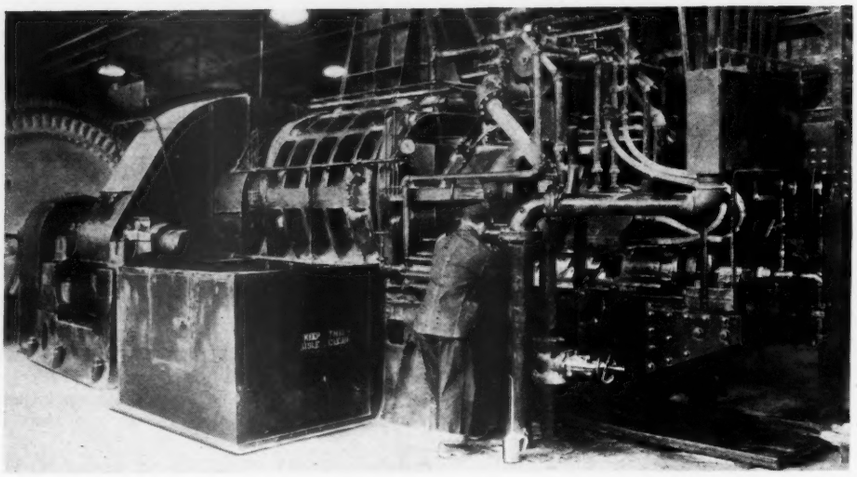
Before organized lubrication becomes a fact, many machines were fitted with marine-type grease cups. These were replaced by pressure lubrication wherever practicable. In some cases the grease cup was taken off and mounted on one arm of a Y, the other arm being the head of pressure system. The cup was left on so that the machine operator could screw the cover down in case lubrication was required before the oiler made his next visit.

At the end of each day the oiler makes a list of materials he will need during his next shift. He deposits this list in a box in the locker room when he rings out at the end of his shift. Then the lubrication leader collects all lists, totals them and makes out requisitions for what lubricants the men in his shift will need the next day. Those requisitions are presented to the man in charge of the main lubrication system. All oil and grease are then delivered to substations, sixteen of which are located at strategic points throughout the plant. All oil and grease are ordered by code number. It is easier, and no supplier's name gets into the plant. All deliveries are made during the day shift, principally because one man is kept continuously in the storeroom at that time. Chances of error in handing out wrong code numbers are thereby greatly lessened.

The cost of lubrication is charged directly against the cost of the item being produced. Thus the unit cost of

lubrication (as well as other maintenance charges) just as it does the cost of materials, direct labor, etc. The maintenance engineer, through the cost department, sends a monthly bill to each of 88 producing departments.

Another thing which is being constantly watched is bearing failure. Each one is carefully analyzed, and the results of the analyses are incorporated in lubrication routine so that the same error is rarely made twice. Also, such analyses are given machine builders as guides to better manufacturing.



The lubrication department is on the point system of wage payment

Last, but by no means least, in the story of lubrication accomplishment at The B. F. Goodrich Rubber Company is the subject of safety. Oiling and greasing machinery is hazardous business at best. It is bound to be dangerous in the very nature of things. Nevertheless, Goodrich engineers report that there has not been a single lost-time accident in the lubrication division for more than a year—and that year involves 150,000 man hours. Every effort is made to remove the hazardous element from the job. Machine guards are used where needed. Grease and oil connections have been installed wherever it is at all feasible to do so. Goodrich knows that conservation of life and reduction of injuries must be guaranteed regardless of monetary cost.

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PRODUCTION CONTROL

3. *PLANNING—Materials*

Thomas M. Landy

THE PLANNING section is the most important single unit of the entire production control structure. It should therefore be the strongest section of any manufacturing organization, yet many executives are not even convinced that any great amount of planning should be done. What is still stranger, they will not admit that there is any necessity for it.

"Production planning is all right," one assistant works manager declared; "but if you have good foremen, it's unnecessary. System is all right, you know, but if you have good men on the job, you don't need any system."

This statement is just as ridiculous as saying to a machine-tool salesman: "Your new boring mill is all right, and I know it's twice as fast as the old one, but we have a good mechanic on that job and we don't need any new machines." This is the voice of the reactionary.

Then there is the other great class which fights tooth and nail against planning on the basis of the possible loss of prerogatives. But planning is necessary and vital to any concern which intends to remain in business.

Ordering—the determination of what work is to be done—is the first step in production planning, hence it is very important that it be done speedily in order that the functions following the ordering will be permitted the maximum amount of time. Second, it must above all be performed accurately, for if the ordering is wrong, the error is liable to accumulate for months in shops working under a long manufacturing cycle. When the error is finally discovered, the part must be brought through a second time, thus tying up in-process inventory as well as floor space.

The shortest path to accurate ordering is the complete preparation of data in the engineeering department so that when the drawings, drawing lists, or other forms arrive in the planning section, nothing more has to be done so far as deciding on material or sizes is concerned. No resort has to be made to shop practice; accurate prints, kept up to date at all times with manufacturing practice, preclude that.

In those sections where the separate title block or the

material list is used (See FACTORY *and* INDUSTRIAL MANAGEMENT, Feb., 1933, pages 66 and 67, ordering becomes a very simple procedure. Instead of its being necessary to employ experts to do the ordering, it becomes clerical routine which any typist can perform. The drawing list shows the number of material lists required for any given job. As rapidly as material lists are prepared for new jobs, the drafting room forwards them to the planning section. Copies of material lists are kept on file for use on all repeat manufacturing jobs.

The material list as forwarded from the drafting room shows the quantity of material for one set of parts used to make one unit covered by the drawing number heading the list. A clerk in the planning section determines the number of sets of material required on the particular requisition, and this number is the multiplier that determines the quantity of each part to be ordered.

After the engineering department prepares the drawing lists in the prescribed manner, they are blueprinted and sent to the planning section, where they are exploded by the order clerks. Thus we have the data emanating from the engineering department in one of two ways—through a copy of the title block, or a drawing list.

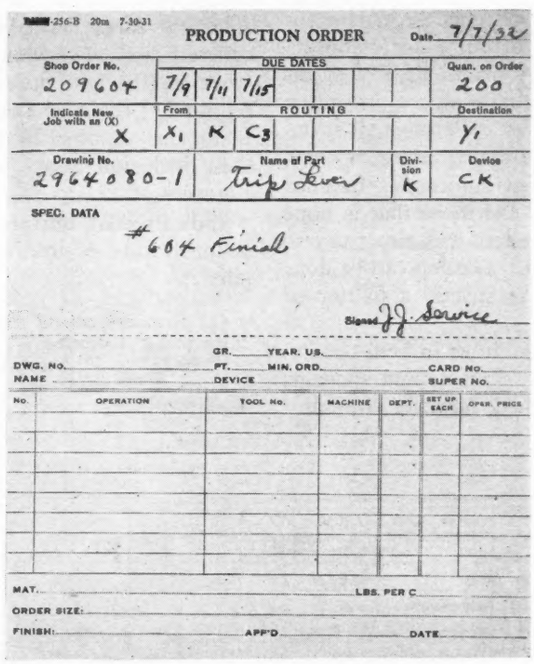
We are now ready to explode this data onto the individual orders. In factories using the hectograph method of paper preparation, the hectograph original (see Feb., page 66) is used. The orders are prepared in sheets of eight individual orders to facilitate hectographing. Good hectographing depends a great deal on good penmanship. If the orders are to be typed, the routing is exactly the same, except that sheets of eight orders each are typed on a special typewriter.

It is important to state on the order any special information or data. Likewise a note should be made as to whether the order is a subassembly or an assembly. When raw material advance information has been issued, it should be so stated.

In the hectograph method of preparing paper, the order clerk fills out the entire card except dates, departmental routing, and material, and passes it along to the material specification man. The more accurate the details filled in by the order clerks, the easier it will be for everyone else along the line to do his part of the job.

Where paper is being prepared mechanically (to be described in a later article), the order clerk fills out the small production order shown, in Figure 1, on all orders coming through for the first time, and passes it on to the material specialists, if material specification is not taken care of on the drawings. Then the order is passed on to the planner, who sets up the routing and pricing. On all repeat orders—that is, those parts for which dupligraph plates already exist—the order card shown in Figure 2 is filled out by the order clerk and sent to the dupligraph section. All items which are set up on stock cards in the inventory control section are ordered by removing the second card from the file, scheduling it, and sending it to the dupligraph section. This routine is carried out whenever the order point is reached.

OUT OF a number of "systems" now in successful use, Mr. Landy has lifted practicable ways to control production—which you, in turn, may now lift and apply to your own job. In this third installment he discusses the work of the planning section as it is related to the ordering and specification of materials



PRODUCTION ORDER Date 7/7/32

Shop Order No.	DUE DATES						Quan. on Order
209604	7/9	7/11	7/15				200

Indicate New Job with an (X)	From	ROUTING					Destination
X	X1	K	C3				Y1

Drawing No.	Name of Part	Division	Device
2964080-1	Trip Lever	K	CK

SPEC. DATA

#604 Finish

Signed J.J. Service

GR. YEAR. US.
DWG. NO. PT. MIN. ORD. CARD NO.
NAME DEVICE SUPER NO.

No.	OPERATION	TOOL NO.	MACHINE	DEPT.	SET UP EACH	OPER. PRICE

MAT. LBS. PER C
ORDER SIZE:
FINISH: APP'D DATE

Figure 1. Production order filled out on all orders coming through for the first time, if material specification is not taken care of on the drawings.

It can be seen that the same parts may often appear on various types of apparatus. In fact it is considered good engineering to follow this policy, since it reduces the number of parts, cuts out needless duplication of drawings, etc. But by the same token inventories might go sky high if every order section using a certain part issued orders for it, when perhaps tomorrow another section might order the same part. It is to eliminate this wasteful practice that the ordering card illustrated in Figure 3 has been devised. On it are listed the various types which use the part so that when an order is placed it is written up as one order to cover the needs of all types. Usually the finished part is carried in the stockroom of the section using the greatest number. This coordinated ordering is supervised from the production manager's office.

The ordering quantity should not exceed a certain number of weeks' consumption, based on authorized requirements and on estimated sales plus local conditions. The order point is determined largely by the following:

1. When raw material is not common to other component parts
2. Competitive delivery on such things as malleable iron, steel castings, and drop forgings
3. Component parts on which raw materials are common to other parts

Local conditions must govern these conclusions also,

but taking these things into consideration, the order point is usually determined by the following rule: Quantities should be such that inventory carrying charges do not exceed the set-up costs.

The ordering section, then, performs the function of saying *what* is to be done, and does it in one of four ways:

1. Hectograph original
2. Production order (new jobs)
3. Order card (repeat orders other than stock items)
4. Stock card

In the first two methods, the paper is passed along to the material specialist for material calculation; in the second two, it goes direct to the dupligraph section, since the material has been calculated when the card was originally set up.

We now know *what* is to be manufactured, and the next step is to decide the most economical material to use. It is right here that waste and spoilage can be reduced to a minimum. It is the old story of locking the stable door before the horse is stolen.

Material Specification—The proper place to specify material is right in the drafting room at the time tracings are being made. However, there is much argument for and against this, and since many of our older manufacturing organizations have so many prints already in existence, there is justification in listing material utilization as a function of the planning section. Perhaps all specifications cannot be made in the drafting room anyway, since the average draftsman is not sufficiently familiar with manufacturing methods, but the more that is done at the time tracings are made, the less it is necessary to do later on in the planning section. The job can be done equally well in either place. It is strictly a matter of time-saving.

Every one is awake to the possibilities in better material utilization, with its reduction of waste and spoilage. The surface has only been scratched, however, for most of the activity has been on the other end rather than on planning so that there will be less waste and spoilage.

Upon receipt of the original under the hectograph method, or on receipt of the production order under the mechanical method, the material specialist will start setting up the planning card, or lower half of the production order.

Since this is such a very important function, great care must be taken to call for the most economical size of material, bearing always in mind the standard sizes carried on hand, the tool equipment, and the machine tools available. It is likewise just as important to figure the quantity accurately. Care should be taken to make use of standard specification numbers in plants having such a code. Material should be recorded on the planning card as follows:

Sheet material
1. Length, width, thickness, gross and net weight of the sheet.
2. Length and width of the strips to be obtained from the sheet.
3. Number of punchings to be obtained from a strip.

Bar stock
1. Length and size and the gross and net weight.
2. Number of pieces to be obtained from a bar.

Castings
Gross and net weight.

Wire
Size, gross and net weight.

Insulation
Size, gross and net weight.
Number of pieces per sheet.

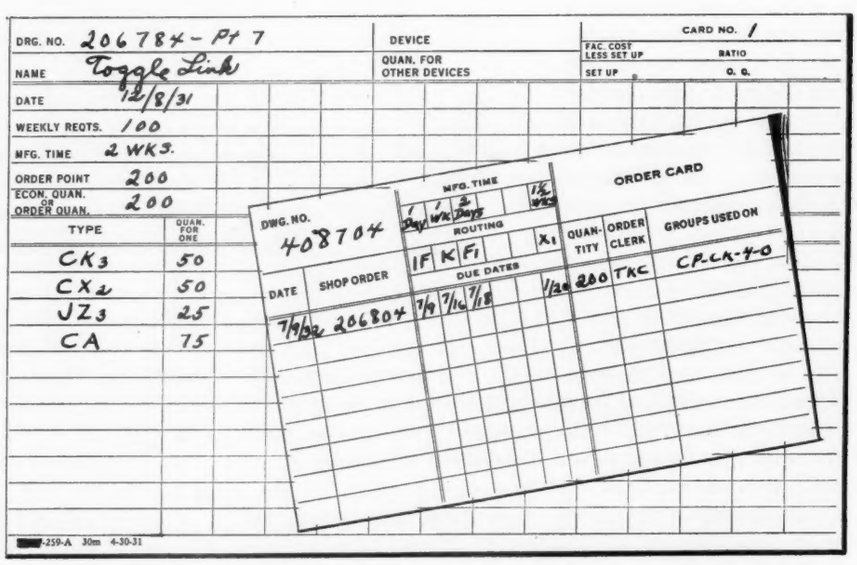
To provide a definite form of ordering materials from the order and stores department, the following examples have been developed to cover the ordering of all large quantities of material:

(a)—1½" dia. x 60" HD. Cu.-M-590-CL "A" Ex. Size 3,700 No. c
(b)—2"x4"x14" Mach. St. M-503 Ex. Size 3,200 No. c
(c)—⅛"x40"x40" Sheet St. M-639—Ex. Size 5,700 No. c

This form can be used when the stores department is required to deliver material to the size stated. Corresponding forms have been developed to cover materials ordered for delivery in multiples of a given length; in stock lengths (the ordering department cutting to length required); for steel sheets or plate steel delivered to the factory as supplied by the mill. Lack of space prevents their inclusion here. Abbreviations used are listed in Figure 4.

Indicative of uniform material information which is so much to be desired, the following data have been compiled:

(a) Standard cut-off allowances
Up to 1½" diameter ..... 1/8"
From 1½" to 3" diameter ..... 3/16"
From 3" diameter up ..... ¼"
These allowances are for cut-off tool only. Additional allowance



Figures 2 and 3. The smaller of the two cards is used on all repeat orders. The larger lists the various types that use the part, prevents needless duplication, keeps inventories within bounds.

must be made for facing, sawing, and similar operations.

(b) In all bar and strip items, except those ordered to "exact length," the weight given shall include 10 per cent to cover waste.

(c) The weight of parts obtained by cutting sheet steel or steel plate shall be figured by dividing the weight of the plate or sheet by the number of pieces that are obtained from the plate or sheet and multiplying by 100.

(d) All weights must be given in pounds per hundred.

(e) When order specifies "exact size," it is understood that, depending on the quantity and size of part, the order and stores department shall decide whether to purchase outside or apply stock material, cutting to size before delivery to factory.

(f) All orders for steel plate, other than Universal Steel Plate, shall include 1" width and 1" length to permit resquaring. This applies to plates as received from the mill only.

(g) All Universal Steel Plate orders shall include allowance for $\frac{1}{8}$" (plus or minus) variation in width and additional allowance of $\frac{1}{8}$" for camber every 5'. Allowance must also be made for "waste" in cutting to length. The mill should add 1" to the total of multiple length given, unless otherwise stated.

(h) Flange quality, special tolerance steel plate shall be ordered only for parts to be "cold formed" in a die.

(j) Flange quality steel plate shall be ordered for construction of parts of oil tanks, etc., when part is to be given a severe cold bend.

(k) In no case shall any one of the above classes of steel plate be substituted for another class without written approval of the material specialist.

MATERIAL SPECIFICATIONS AND CLASSIFICATION ABBREVIATIONS

MATERIAL

Aluminum	Al.	Max-el Tool Steel	Max-el Tool St.
Ascoloy	Ascoloy	Monel Metal	Mon. Met.
Brass	Br.	Machine Steel	Mch. St.
Bronze	Brz.	Malleable Iron	Mal. I.
Bronze, Phosphor.	Brz. Ph.	Nickel Steel	N. St.
Compound	Compd.	Naval Brass	Naval Br.
Copper	Cu.	Press Board	Press Bd.
Cold Rolled Steel	C. R. St.	Slate	Slt.
Channel	Chan.	Steel	St.
Cast Iron	C. I.	Steel Sheet	St. Sh.
Everdur	Everdur	Steel Strip	St. Str.
Fiber	Fbr.	Steel Plate	St. Pl.
White Fiber	Wht. Fbr.	Steel Spring	St. Spg.
Black Fiber	Blk. Fbr.	Steel Stainless	St. Stnls.
Leather	Lthr.	Steel Tube	St. Tube
Leatheroid	Lthrd.	Tool Steel	Tool St.
Lead	Ld.	Wrought Steel Pipe	Wrt. St. Pipe

MATERIAL CLASSIFICATIONS

Annealed	Ann.
Unannealed	Unann.
Centerless Ground	C. G.
Square Edge	Sq. Ed.
Slit Edge	Sl. Ed.
Round Edge	Rd. Ed.
Hard	Hd.
Half Hard	½ Hd.
Spring	Spg.
Extra Spring	Ex. Spg.
Soft	Soft
Dead Soft	Dead Soft
Drop Forging	D. F.
Metal Section	M. S.

MISCELLANEOUS ABBREVIATIONS

Class	Cl.	Special	Sp.
Commercial	Com.	Structural	Stru.
Diameter	Dia.	Thickness	Th.
Exact Size	Ex. Size	Tolerance	Tol.
Grade	Gr.	Universal	Univ.

Figure 4. Good planning prescribes definite forms of ordering materials from stores. The abbreviations used in the text examples are listed in this table.

It is accepted that substitutions of material must be made at times, to fill production requirements, whenever it is impossible economically to procure the desired material, or when the time allotted is insufficient and a reliable substitute is available in a shorter time.

When a substitution of material is desired, the raw stores involved will refer the material book to the planning section with the recommendation of the available substitute. The planning section will investigate and, upon approval, have the new material specification typed on the lower part of every copy of the material book, sign the identification tag in ink, and issue additional time vouchers if necessary.

Extra cost due to the substitution of material will be taken care of by time vouchers, stamped "due to substitution of material" and charged to the *regular* shop order, except when the substitution of material is due to an error in a department, in which case the vouchers are stamped "extra work" and an extra cost slip is issued. On an extra cost over $3, an inspector's report is necessary, charging the waste to the department responsible for the error. All piecework vouchers stamped "due to substitution of material" must also be stamped "special price," and be signed by the planner. Engineering approval must be obtained in all cases where a different kind of material is substituted for the kind called for on the drawing; all substitutions of different *sizes* of the *same material* must be approved by the planning section.

NEXT month the author continues his observations on the planning section and its functions with a discussion of scheduling, routing and pricing, tool planning, and factory layout

Put Power Lines on a Diet—

H. C. Jenks

Control Engineer
Westinghouse Electric & Manufacturing Company
East Pittsburgh, Pa.

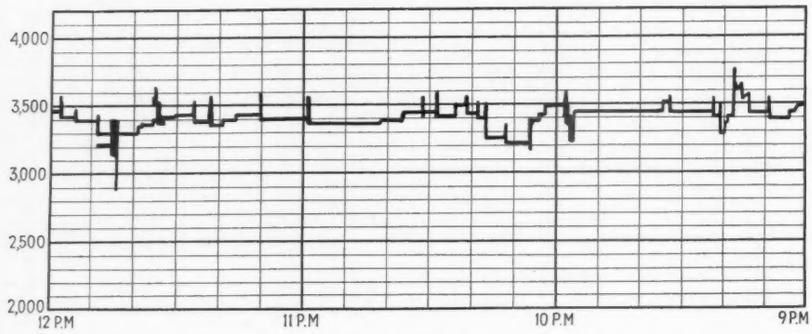


Figure 1. It's the peaks in electrical loads that help to make high demand charges. With manual control it is difficult to keep them down. This chart was taken in a plant where it was desired to keep the total load from going above 3,500 kilowatts.

PLANT managers have a vital interest in the economies that can be made by regulating load factor and power peaks. In this article will be described some methods by which power costs may be reduced through the judicious application of load-regulating equipment and production scheduling.

So far as power supply is concerned, industrial plants may be divided into three classes:

1. Plants that buy all their power.
2. Plants that generate a portion of their power but have to purchase additional blocks to meet their needs.
3. Plants that have varying loads and generate power in varying quantities, so that they may at different periods buy power, operate on their own power supply, or have a surplus to sell to the utility company.

The first two types, particularly, are interested in the cost of purchased power and in the rates charged. The third type is likewise interested, but often to a lesser degree, since mutual arrangements that are advantageous to both parties can frequently be made.

Under usual power contracts one of the most effective methods of reducing power costs lies in maintaining definite load factors. Load factor is the ratio of the average power required to the maximum demand. For example, a mill had a demand of 5,000 kw., operating on a load factor of 36 per cent, and consumed 1,300,000 kw.-hr. a month. On a typical public utility schedule the power bill would be approximately $17,400 a month. At 100 per cent load factor the net cost of this energy would be approximately $12,300. The difference between these two figures, $5,100 a month, is the amount this mill was penalized for inability to maintain 100 per cent load factor.

It could not control its demand to operate at 100 per cent load factor, but study of the demand charts showed that certain large machines were frequently used when peaks occurred over the remainder of the plant. These machines could be shut down for short periods without materially lessening the monthly output. It was estimated that use of a plant load regulator to disconnect these machines from the line when the total kilowatt load reached a predetermined value and to reconnect them after the peak had passed would bring the load factor up to 45 per cent and the demand down to 3,800 kw., cutting $2,000 from the monthly power bill.

Another effective method of reducing power costs lies in lopping off power peaks, which often results in the ability to take advantage of higher load factors without danger of exceeding the contract demand clause. Figures 1 and 2 show the improvement that can be obtained in certain types of plants by the use of constant-current regulators. A chart of the load drawn by a specific plant operating under manual control is shown in Figure 1. The load is being maintained as closely as possible at 3,500 kw., but it varies considerably and has a number of fairly wide peaks, although in this plant the load was more than usually constant. The improvement made by substituting a load regulator for manual control is shown in Figure 2. It was possible to limit peaks, raise the load factor materially, and increase efficiency.

The industrial plant represented by Class 1 finds it has the most difficult problem in peak demand reduction and load factor improvement. Its only methods of reducing peaks are to drop off certain machines when the plant load becomes too high and to watch the plant load when restarting these or other large machines.

Frequently material savings in power costs can be

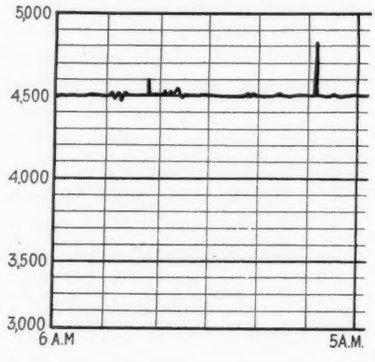


Figure 2. With a load regulator on the job, little peaks do not have a chance to grow into big ones.

and keep little peaks from growing into big ones

Reducing power bills requires close cooperation between the maintenance and production departments. The maintenance department must decide how the problem can best be attacked. It's up to the production department to schedule operations so that power demands are kept at minimum values

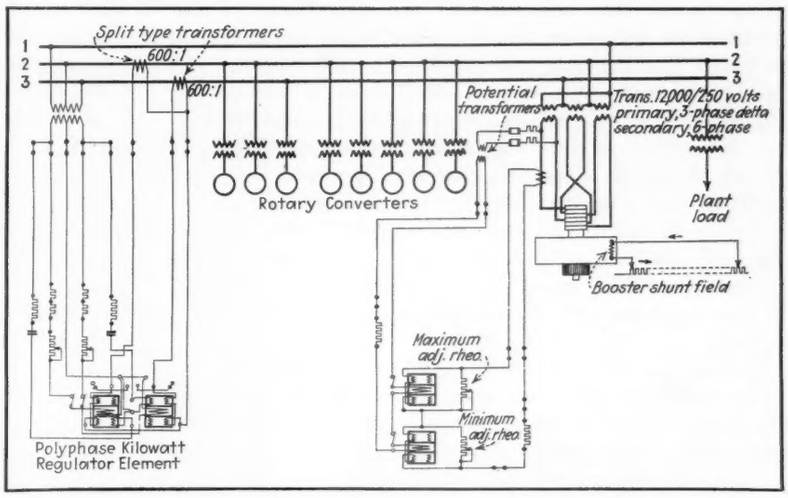
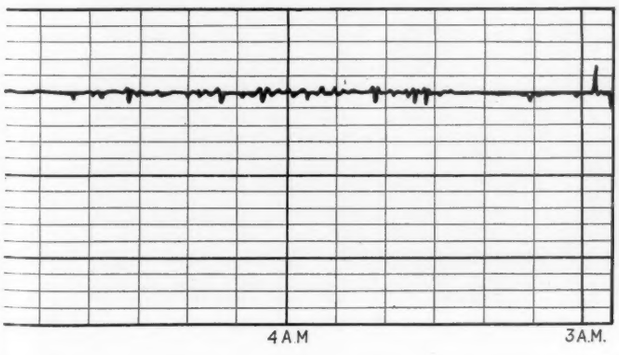


Figure 3. The regulator for synchronous converters carrying an electrolytic load raises or lowers the amount of power taken by bucking or boosting the voltage of the converter by adjustment of the booster generator shunt field.

realized by careful grouping of the feeder circuits and the motors on these circuits, with the installation of demand limitators, which operate to "limit" the demand by giving a warning, or by disconnecting certain loads when a predetermined demand has been exceeded and reconnecting them when the peak has passed. Such devices can be very effective in reducing power bills.

The unfortunate feature of this type of demand limitation is that in order to be most effective it requires considerable planning of circuits and, in established plants, possibly an expenditure of appreciable sums of money for rearranging power circuits and feeders. These circuits can be arranged much like a river system, in which the various tributaries can be guarded by limitators, with other limitators placed at strategic machines in these branches. An expenditure for such purposes is, in many cases, more than worth while. Then new plants or additional units in old plants can be laid out so that definite economies can be realized from this type of peak limitation.

Another point that can be observed in Class 1 plants is not to start heavy machines when the demand is approaching the maximum allowed. Load analysis may indicate that material savings can be effected by starting such motors before they are required, allowing them to run light until needed.



Material savings can often be made by an analysis of the processes carried on in the various departments. Process times may be scheduled so as not to overlap and cause excessive power peaks. This is where process planning or production layout can be of material aid to the management in controlling power costs.

Another method of reducing peaks is to provide a total load indicator convenient to a heavy-demand machine, with instructions to the operator to control the machine feed in accordance with the feeder load indicated on the instrument.

The problem of the manager of a plant in Class 2 may be simplified somewhat. The power plant is under his supervision, and he may dictate its performance. Since power is purchased to augment that which is generated locally, load regulators can be used to limit the amount of purchased power and help the local supply to meet the peak demands.

Load regulators of this type operate on incoming power and serve to maintain it at predetermined levels. A very important feature of such regulators is that by maintaining purchased power at virtually constant levels they establish a high load factor on a minimum base level without the danger of incurring excessive peak demands because of plant load surges.

The manager of a plant in Class 3 is fortunate. At times considerable energy in the form of byproduct fuel is available; a contract is therefore made with the utility company for an interchange of energy. The utility will feed blocks of power to the industrial plant when it is heavily loaded and not producing much byproduct fuel; when the plant has considerable byproduct-generated power available, it is turned into the utility's lines. Rates of power interchange can be arranged at such levels and cost bases that mutual benefits will accrue to both parties.

Load regulators for plants in Classes 2 and 3 may

take several forms. One is used in conjunction with a booster converter. Changes in the controller circuits actuated by the regulator can be made to enable the regulator to handle governor settings on generator equipments, rather than the fields of the converters. This modification makes the apparatus applicable to all types of plants that generate and purchase or sell power.

The diagram of a typical installation is shown in Figure 3. The watt regulator measures the total incoming kilowatts. If this load tends to increase above a predetermined amount, the "lower" contacts of the regulator will close and, through the reversing switches, energize the motor of the converter-field rheostat to decrease the voltage of the synchronous converter. Conversely, if the power decreases, the "raise" contacts of the regulator will close and increase the converter voltage.

In this case the synchronous converter supplies power to an electrolytic load; variation in the voltage will vary the power taken by the electrolytic cells and thus compensate for variations in the plant load.

The load regulator control unit consists of a watt element wound as a solenoid. It has the advantage of being inexpensive, but meets most of the requirements for accuracy. A slightly more expensive and accurate device is the Kelvin balance regulator, whose sensitive element is the same as that of a wattmeter. Therefore, this device has the same accuracy as the device that is measuring the power input to the plant.

Somewhat similar equipment may be used in the control of processes rather than in total plant-load regulation. A plant operating a 1,250-kw. motor-generator set found it necessary to maintain constant current in some electrolytic cells. This motor-generator is shown in Figure 4. The regulating equipment is on the third panel, reading from left to right, in Figure 5. The simplicity of the load-regulating device is indicated by the fact that this panel also contains the control for the generator.

Instead of a watt element this regulator contains a voltage element that measures the voltage drop across the interpole winding. This voltage is a true function of current and temperature in an installation operating 24 hours a day over a narrow load range. Since both the regulator coil and the interpole winding are made of copper, the temperature coefficients of resistance of the two are similar. Thus, errors created by changing temperature conditions in the substation are negligible.

Obviously, other schemes of load regulation are available, with other types of equipment that will enable a plant manager to place his enterprise on a better load factor and peak demand basis. On a problem that is rapidly assuming proportions that can no longer be met with apparent nonchalance, the industrial plant and the utility company must work together and take advantage of every factor that will result in mutual benefits.

Reductions in the cost of power mean substantial savings to producers and consumers alike. Automatic load regulators serve as silent but ever-alert traffic directors, so to speak, that guide the flow of electrical energy into such channels and in such quantities as will make for the highest efficiency and greatest net return to both parties.

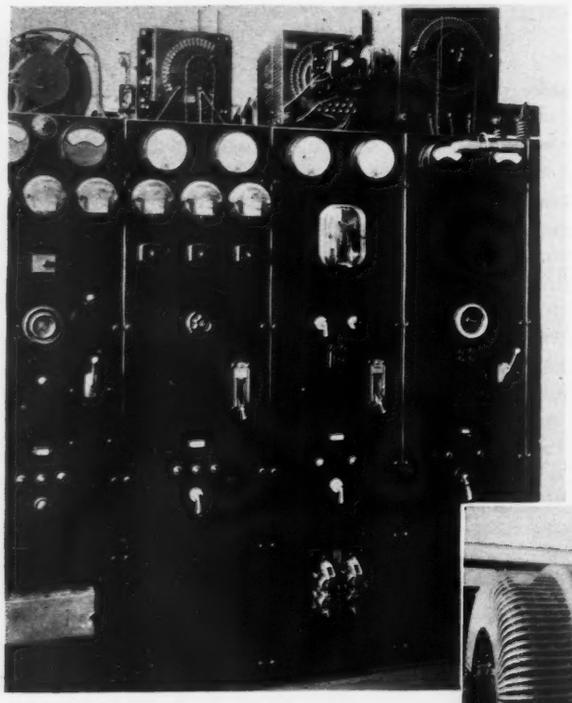


Figure 5. The generator control equipment and load regulator for the motor-generator set shown in Figure 4 are mounted on the third panel from the left.

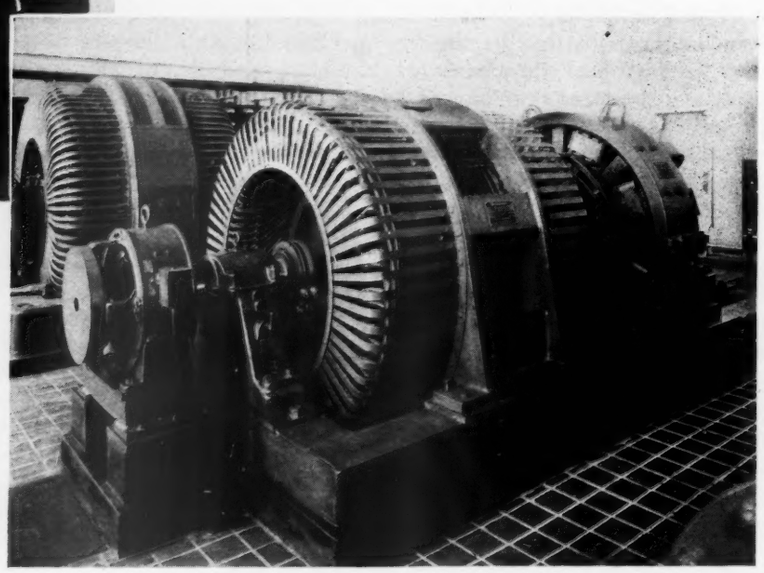
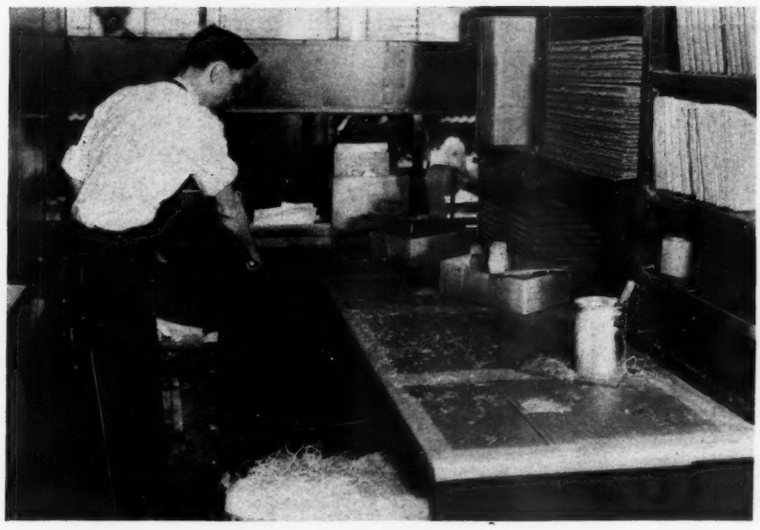


Figure 4. On a diet. A load regulator controls accurately the amount of current delivered by this 1,250-kw. motor-generator set to electrolytic cells.

Look at this work place. No wonder he



PACKS 30% MORE!

A TREMENDOUS increase in packers' efficiency has been brought about at Abbott Laboratories, North Chicago, Ill., by the use of packers' benches specially designed to fit the particular packing problem of the plant.

Formerly packing stations were much like those in most shipping rooms. The waste motions attracted the attention of some of the Abbott people interested in methods betterment work, and they set about producing something which would be better. The evidence of their first work is still present at one packing station, in the form of a packer's bench which was made in the plant's own shop. After the design had been worked out and tested in use, it was economical to turn over the manufacture of the other equipment to a maker of steel shelving.

Each packing bench stands at right angles to the conveyor which brings the orders for packing with good light from the left. Each bench is in the same relative position, so that a man can be transferred to another bench without affecting his motion habits. The bench stands about seven feet high, and at working level broadens out into an adequate working surface. The upper part of the piece is divided into bins which exactly fit the materials required—six different sizes of box set-ups, excelsior pads, and so on. A small tray projecting from the bins contains all sizes of labels used. A gummed tape machine and a silicate pot are at the working level in the rear.

Beneath the working surface is an excelsior bin at the right, and at the left hangs corrugated board. The roll of corrugated is hung on the rear side of the bench, and feeds through a slot. The back of each bench is thus utilized, and likewise where the bins in front are shallow—as for small pads and liners—the space at the back is utilized for another supply of pads and liners. The materials most frequently used are, then, directly in reach of the packer and in front of him. But those materials which he uses less frequently are found in pigeon-holes on the back of the bench behind him.

In consequence, the packer can work with practically no waste motion. What he needs is right at hand. All he has to do is decide what box he needs after he has taken the order from the conveyor, set it up on his bench, pack the order into it, then place the packed carton on the outbound conveyor. The saving through increased output per man is in the neighborhood of 30 per cent. Each man is working by himself, practically in a private office, so the old-time visiting of the open bench has been eliminated.

•

A Raised Check

OUTBOUND orders must be carefully cross-checked in many plants before shipping. The logical place to have this job performed is between order-picking and packing—which usually means a bustling room where concentration upon the task is none too easy. At Abbott Laboratories, the checking station is given comparative isolation by raising it about four feet off the floor.

The order pickers place the tote-boxes of orders on a belt conveyor. The belt moves, however, only at the will of the checker. At her table on the platform is a hand switch. When she has finished checking an order, she presses the switch and the next box comes up.

The cross-checked order leaves via gravity rolls and comes to a live-roll conveyor at the head of the packing line. This conveyor, too, moves only occasionally. The orders lie here until any one of the eight packers needs work. All he does is press a button—and the next tote-box comes to him.

Factory Management *and* Maintenance

A consolidation of *Factory and Industrial Management* and *Maintenance Engineering*

MARCH, 1933

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Debut

HERE is the first issue of *Factory Management and Maintenance,* a consolidation of *Factory and Industrial Management* and *Maintenance Engineering.* It serves both functions—management and maintenance.

Some of the material deals more directly with management, some more directly with maintenance. Each supplements the other; together they provide a balance in the kinds of data necessary for thorough cooperative action in plant operation.

Faced with the greatest challenge you have ever had, you men responsible for plant operation have need of the direct help that this issue and the future issues will afford.

The editors want you to be just as free as ever with your comment, advice, and questions. It's your magazine—make full use of it to your advantage, our satisfaction.

•

Strike One for Prosperity

WRIGLEY (Spearmint and Chicago Cubs) made the one best prosperity move when he raised wages and salaries a short time ago. Every concern possessing the surplus or the income that will permit taking the same course should fall in line. Wage earners do the bulk of the buying, can't buy on a prosperity basis without proportionate incomes.

•

Red Maintenance

A RECENT news report from Russia reminds of the necessity for preventive maintenance. In the New York *Herald Tribune* Ralph W. Barnes tells of the report from Magnitogorsk that of forty small locomotives used for transportation of coke from ovens to blast furnaces only fourteen were functioning. Also that one of the greatest drawbacks in Russian industrial plants is the dearth of small spare parts, with minor breakage at times causing formidable tie-up.

Especially serious is such a condition in a new industrial nation. Serious enough, though, even where industry is well established. In our own established industrial nation the past three years have witnessed much neglect of maintenance, ordinary as well as preventive. Stock bins for spare and replacement parts are far from full.

The situation will bear looking into in any plant. Suggested: A careful check-up.

•

Good News

FOURTH release enumerating expenditures shows commitments totaling twenty-four millions plus for rehabilitation in the twelve Federal Reserve Districts.

The money is being spent for "new machinery, new buildings, lighting equipment, modernization, rehabilitation, repairs, tools, alterations, replacement, cost reducing improvements, power house rehabilitation, capital expenditures." The items are quoted from the release, presumably are the terms used by the plants spending the money.

Rehabilitation benefits the plants making the purchases by providing the wherewithal for making a lower-cost product. It benefits the makers of the equipment that is bought.

Congratulations to the Rehabilitation Committee. May it find continued acceptance for its efforts.

•

Dissipating Dividends

INDUSTRY buys coal to wrap it up and sell it. The money spent for coal is operating capital and the manner of its spending has much to do with the yes or no of dividends.

If the power made by burning the coal bought by operating capital is wastefully transmitted, what of earnings? Power factor penalty and high demand charges don't pay dividends.

These thoughts were expressed by an engineer in urging efficient application of power to manufacturing loads. They suggest intensive investigation of size and character of loads; best drives to fit fixed conditions or layout;

possibility of changing conditions or layout for greater economy.

It's imperative, of course, to wrap for sale as much of the coal—or the operating capital—as possible.

•

Costly Saving

SEEKING ways to cut expenses in a large plant, someone hit upon the idea of buying lower-priced lubricants and replacing an experienced oiler with a cheaper man. The possible savings were a few dollars a week.

Within a short time several big antifriction bearings failed, shutting down one of the most important machines in the plant. These bearings cost several hundred dollars apiece. Two or three weeks passed before new ones could be obtained and installed. In the meantime the machine, with production worth about $300 an hour, lay idle. For every dollar that might have been saved, thousands were lost.

Moral: Good lubricants and men who know how to apply them are two of the most important economies that any plant can institute.

•

Distribution for Prosperity

HERE'S one that will motivate some thinking. Gimbels, New York, is putting into practice the theory that a maximum quantity of goods put into circulation at the earliest date, regardless of the amount of profit involved, will be an aid to speedy business recovery.

They announce purchase during February, in twenty-eight states, of merchandise worth one million plus; say they will offer these goods for twenty business days at about cost.

Despite its being contrary to usual belief in necessity for profit, the plan appeals as a temporary method of distributing things that people can use and, in doing so, distributing some purchasing power to the factories that made them.

•

Analyze Maintenance Now

PROGRESSION from the simple to the complicated is the most efficient procedure. With personnel depleted and operation confined to a relatively small proportion of the equipment, maintenance conditions now afford good opportunity for analysis and planning for orderly administration.

In most plants the work to be done by the maintenance department and the responsibilities to be carried by the department will stand analysis. Written specifications will establish the relationship to other functions; set forth the details of inspection and upkeep; supply directions for the routine work of the men.

The statement that maintenance is more important than ever because of the necessity for low-cost production in preparing for a highly competitive market is no less true because of its frequent repetition by us. A good man can "fix" a thing after it has failed; a better man will prevent its failure.

Prevention must be based on orderly, planned procedure of the maintenance department as a whole. Apparently it's a sound conclusion that engineered maintenance will be planned while the planning is good in order that operation may be constant when it is most important.

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Electric Eyes Cost Little

NO LONGER is it news that small glass bulbs "filled mostly with nothing" can perform with ease and perfect reliability services that can be accomplished only with difficulty, if at all, by other means. It may be not so well known that intensive research and development have resulted in equipment that is low in price and comparable in ruggedness with many older and more familiar devices. Particularly is this true of equipment that is built around the photoelectric cell. This device exhibits the highly useful property of changing its electrical characteristics under the influence of light. Simple equipment renders that property available for service.

A considerable proportion of all electron tube installations belong in this class. Costing little, a beam of light can not be damaged, never wears out. Hence, if conditions are such that interruption of a light beam can be arranged for the chances are good that a photoelectric relay can be used to accomplish almost any desired ends. The number of such cases in industry is legion. In consequence, many manufacturers have placed photoelectric relays on the market and the price has been brought down to where it is insignificant in comparison with the results that are possible.

Standardized cleaning equipment and procedure bring

A CLEANER PLANT AT *Less* EXPENSE

Wherein management and maintenance work together on the job of choosing the right cleaning equipment for the specific job and setting standard rates for cleaning floors, walls and process machinery

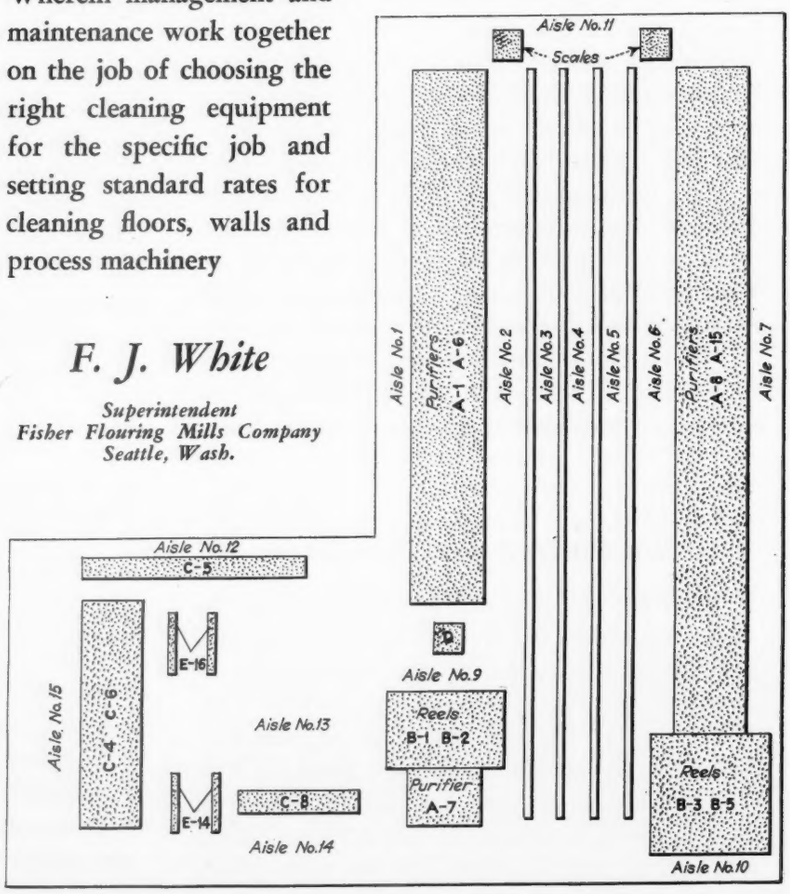
F. J. White

Superintendent
Fisher Flouring Mills Company
Seattle, Wash.

OUR EXPERIMENTS have shown that cleaning is something more than a menial task. For obvious reasons it is an operation of vital importance in a flour mill, which therefore is an ideal full-scale laboratory wherein to work out those standards in equipment and procedure that should give a cash return to plants in many industries. Here are reports of what we have done and data on some of our standards.

In a flour mill the bulk of the dust is collected by suction and is separated from the air by dust collectors. However, some dust escapes and settles on floors, walls, and machines. It was to this aspect of the problem that we devoted a part of our attention—the development of the best equipment and an efficient corps of cleaners.

The experiments carried on by the superintendent's office at Fisher Flouring Mills have included studies of types of brooms, brushes, mops, ladders, scoops, and cleaning fluids. A rough floor calls for bristle far different from that which is used on a smooth painted surface. The length of the handle, although of apparently little consequence, adds a calculable factor to the efficiency of the sweeper. In handbrushes, weight, length of bristle, and the length of handle are decidedly important considerations.



Floor map which guides cleaners in the routine of cleaning and oiling. Each aisle and each piece of equipment is given a code number, and a supplementary chart tells when and how to proceed.

We encountered difficulty in obtaining standard brushes suited to our particular needs, and a statement of our requirements fell on unsympathetic ears of manufacturers. What were to be the dimensions of the back, or spine? What was to be the quality of the bristles? Weight and length of handle were of equal importance; what were they to be? In order to determine the specifications, experiments were carried on with 25 brushes. In the end we found it necessary to design our own brush and broom. Examples of the standard specifications worked out follow:

Handbrush for elevator legs, purifiers, sifters:
Over-all length ..... 13 in.
Length of base ..... 6 in.
Length of handle ..... 7 in.
Brush face ..... $3\frac{1}{2}$x$9\frac{1}{2}$ in.

Brooms for sweeping up grains, screenings, and dust in the head-houses, rough concrete and wood surfaces:
Overall length ..... 18 in.
Center row ..... Bassine
Three rows surrounding center ..... Horse hair
Two outside rows ..... Soft Russian gray bristle
Length of stock ..... 4 in.

Brooms for sweeping smooth or painted surfaces in flour mill:
Overall length ..... 16 in.
$4\frac{1}{2}$-in. stock of Russian gray bristle on hardwood block.

The scoops previously in use were found to be too heavy and varied in type. A scoop was designed to meet the needs of flour and feed mills and headhouses.

Experiment showed that spout surfaces could be kept cleaner with a dry mop than with an oiled mop as used in the past.

We found that a cleaning fluid to be suitable for cleaning our floors must not contain so much oil that the surfaces cleaned would remain slippery; that it must include a sufficient amount of thinner to act as a soluble for grease and flour spots; that the application should leave the floor bright and shiny. For varnished surfaces we have found that a fifty-fifty solution of carbon tetrachloride and coal oil makes an ideal cleaner. Lacquered floor surfaces usually are swept with an oil mop, which cleans as it sweeps.

Sometimes the commercially prepared product is best suited. For example, formerly we used sodium phosphate solution for cleaning walls, and then we found that a trade-named product already on the market served this purpose better.

The question of ladders was of prime importance to the ease and efficiency with which the cleaning operation was to be carried on. It was found that standardized ladders were a necessity and it was discovered that six types were sufficient to meet the needs. A saving in their manufacture was realized by designing the ladders in such manner that all parts are machined to close tolerances.

These parts are kept in store, are numbered, and are assembled according to code number.

Careful analysis and time and motion studies were made of the work to be done on each floor; and standards of tools, time, and routine were set and recorded as standard procedure. During the analysis wall and floor space was accurately measured and recorded. Processing machines were counted, together with bearings, pulleys, shafts, and lubrication points.

Through the medium of time and motion study the most efficient tools and methods have been devised for the upkeep of processing machines. In the past oiling was a separate operation. We have found it expedient to combine oiling and cleaning in order to eliminate waste of oil and duplication of work. Standards have been set, a standard applying to all machines of a similar kind with allowance for unavoidable delays, greater number of spouts, and inaccessibility of the machine.

Belts and pulleys are brushed down on specified days with standard tools and by standard methods. Bearings are oiled on specified days.

Cleaning rates per square foot of wall space have been set, with allowance for wall area which is more susceptible to dust. The frequency with which this operation is carried on has been determined after careful analysis.

Similarly, cleaning rates per square foot of floor space —wood floors, concrete floors and painted surfaces— have been set. Deviations from standards because of surplus dust are taken care of in a percentage allowance.

Standards for cleaning and oiling processing machines, plus the standards for cleaning floor and wall space, together with allowance for personal needs, reasonable delays, and choke-ups gives the standard time of maintenance for each floor.

Routine is equally important to efficient cleaning. Each floor has been diagramatically laid out on a small floor plan which shows the sweeper a work plan for the day. By referring to the chart he knows immediately what are his duties for the day.

In order to insure adherence to the carefully worked out sweeping and oiling procedure, it became necessary to establish a follow-up system. The follow-up is carried on by a bolter appointed by the foreman miller who makes a daily survey of the mill in regard to specific operations such as oiling, bearings, belts, processing machines, walls, and floor surfaces. This check-up is made against the daily report made by the cleaner on the job card. If all duties have been performed satisfactorily the job card is officially okayed. Written procedure keeps the superintendent aware of what the cleaner is doing at any hour. And, what is of equal importance, the cleaner himself is aware of what his duties are at any hour. A map of the floor, such as previously described, is hung at the entrance of each floor.

▲

"Men take color from their surroundings," says Jacob Kindleberger, president of Kalamazoo Vegetable Parchment Paper Company. "A paper mill is a hard place to keep clean. But put a man in a dirty place and he grows slovenly himself. We everlastingly spend money for paint and windows and cleaning, so that we will have careful men who respect themselves, their company, and their product."

· MANAGEMENT SHORTS ·

Belt Moves, But the Work—

An unusual application of a belt conveyor is seen on speedometer assembly at Stewart-Warner Corporation, Chicago. The belt conveyor moves along before the operators' stations. Above it is a shelf, supported by strap-iron legs every three feet. At each assembling station, which may be every three feet, a strap-iron cross-bar is bolted between these legs so that it halts the tray of work before the worker. The belt slips beneath the halted tray. The tray remains here as long as it is needed, then

the operator lifts it over or around the stop, and it moves to the next position.

Where more operators are needed than one every three feet, a short section of gravity roller conveyor is set in above the belt conveyor. The tray of work is lifted onto the rollers when it reaches the station, and travels along this gravity conveyor until the congested area is passed. Then the last operator lifts it down and it resumes its journey by belt. The underside of the belt, returning beneath the bench, brings empty trays back to the head of the line.

It might be thought that the friction of the canvas belt against the halted wooden trays would wear out the belt. Perhaps it does wear out more quickly than if it were allowed to run free. But the installation has been at work for four years, with the belt as yet showing no great wear. So the cost from this factor is hardly worth considering.

A. V. LEVERING

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John Hancocks

A hundred years or more ago Duncan Phyfe signed his name to the tables and chairs which apparently none but he could make, and thus told the world he was willing to stand back of them. Today, in the Bridgeport, Conn., plant of Consolidated Ashcroft Hancock Company, Inc., the men who perform the major operations sign their names to a guarantee which is affixed to every

Guarantee

This AMERICAN Instrument, in addition to carrying our standard Company guarantee, is unconditionally guaranteed as to quality of workmanship by the individual craftsmen who made it.

Many hands and minds contribute to the manufacture of a precision instrument. The major operations involved in the making of this instrument were performed by the men whose names are signed below; men who will not knowingly attach their signature to work that is not, in all respects, the best that they are capable of producing.

The men who have contributed their skill of hand and brain in the creation of this instrument are:

Karl Schubert ASSEMBLER
Donald Wazeau TESTER
A. H. Lewis INSPECTOR
A. Schnitzler FOREMAN

CONSOLIDATED ASHCROFT HANCOCK CO.,
BRIDGEPORT, CONN.

FORM 280-283

instrument the company turns out. Few instruments ever made the round trip on account of faulty workmanship. Since the guarantee plan was inaugurated their number has been fewer by 60 per cent.

•

Superheaters installed in a laundry increased production of flat-work ironers and pressers by 70 per cent, saved 24 tons of coal in 17 days of operation. Still many small industrial plants continue to operate without any help from new equipment that often pays for itself in no time at all.

•

Past Performance Records

Making production or inspection records available for the shop, as a means of eliminating damage, is an important function of management. In a plant of high repetitive manufacture this information is passed on at regular meetings, and the remedy, if available, is applied at once.

In a job-lot plant such as ours—American Hard Rubber Co., Butler, N. J.—some 30,000 items are handled. Some of these are produced three or four times a year, and others perhaps once in every four or five years. The orders are short runs, so that rejections which occur cannot be corrected until the next order is received.

Since supervisors and foremen who are advised of these rejections through routine inspection reports cannot be expected to remember the difficulty after a lapse of months or years, a "past performance record" has been adopted.

Reports which have been issued for a period of two months have shown as high as 60 per cent improvement on some items. Failure to better past performance was noted in only 4 per cent of the items, for which reports

were issued, while the balance showed an average of 30 per cent improvement.

The form, which is simple and self-explanatory, is issued upon receipt of a repeat order. The information is taken from production record cards at the time that the new order is received and is issued to cover only such items on which repairs and rejections have been run over 5 per cent on the previous order.

As most items of our manufacture pass through a

SUPERVISOR DIV. 20
" DIV. 30 PAST PERFORMANCE REPORT Date_____

Your attention is directed to order _____ calling for _____ pcs. of _____ sample #_____ which is scheduled to start _____.

On the last order _____ dated _____ your performance was as follows:

Div. 20					Div. 30				
Made	Good	Scrap	Repairs	Lost	Made	Good	Scrap	Repairs	Lost

Please give this your careful attention so that your record on this new order (which will be shown on the second line of the above) shows the improvement that is EXPECTED.

PRODUCTION SUPERVISOR

process and finishing division, figures are taken from two separate sets of production records. Copies are typed and sent to the supervisors of both divisions, and the original filed in the scheduling office.

When the order is shipped, the original copy is removed and returned to the schedule clerks of both divisions to have the record of the performance on the newly completed order entered. The results are then noted by the production supervisor, and a memo is issued each week to the superintendent as well as the supervisors commenting on the improvements.

This routine is one that can be applied wherever production records of the progress on orders are kept. It requires very little additional clerical effort, and is welcomed by the manufacturing divisions as a means of helping them in their perpetual battle with rejections and repairs.

C. A. HUBNER

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And in Boston, Canada Dry has found a way to count crates of filled bottles as they go out to the shipping room. The photocell is on the job.

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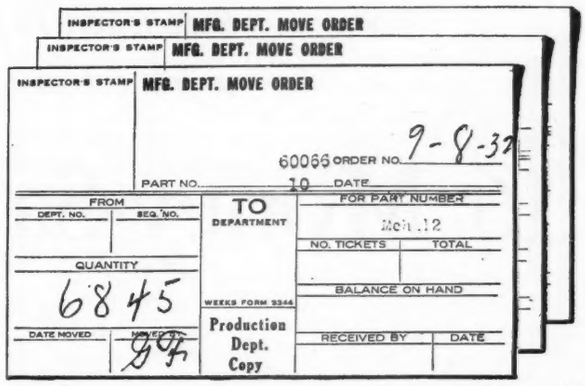
No Wrong Moves

Illegible move orders are a nuisance and an expense—for they muddle up records, and sometimes place a strange tote box full of parts at a machine where such parts were never before seen, while an operator in a distant department waits impatiently for his missing work. But department dispatchers are not always so good at the clerical parts of their jobs—with a particular weakness in handwriting.

Not long ago, in a midwestern plant, a new system was installed of printing up time tickets on small hand-operated addressing machines; the machines and plates were kept right in the factory department. The method saved money and errors—but that is another story.



Someone got an idea of doing the same thing with move orders. After all, practically every move is standard, and might just as well be put on an addressing machine plate. So this was done. The plates are kept by the department dispatchers. They print up in advance move orders for the most frequent moves, and simply date them by hand. On less frequently recurring moves, they print up a single move order as required.

By hitting the machine a sharp clip when he prints up an order, the clerk gets a good carbon copy on the pink stockroom copy as well as on the white production department original and the manila tag which stays with the goods. The orders are now always legible, and all the errors due to illegibility have disappeared. Incidentally, the new method is so much quicker that it has saved a good deal of expense.

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In Granite City, Ill., the National Enameling and Stamping Company uses photocells to control metal ware entering its automatic enameling ovens, thus insuring uniform heat treatment.

Somewhere in your plant there's a job for one or more of these

16 Money-Saving Controls

G. A. Van Brunt

Associate Editor

1 Motor-driven pumps in one of the deep shafts of a Western mining company raise mine water from two lower levels to a higher level, from which it is pumped to the surface. Manually operated equipment was used, and meant that careful, skilled men were required to insure proper working of the system, with the ability to handle any emergency that might arise. Automatic equipment was installed at a cost of about $8,000. In the first six months of operation a saving of $5,000 was realized, indicating that the savings may approximate $10,000 a year. At this figure the gross return on the investment is 125 per cent.

2 In the plant of a well-known manufacturer of lineoleum 27 mixing machines were formerly driven by direct-current, adjustable-speed motors through large, open, spur gears on which maintenance costs were high. Study of requirements led to the installation of full-automatic, two-speed control, using an alternating-current motor and speed reducer, on one unit. The new control provides automatic changing of speed and shutdown at the end of the mixing cycle. Records showed a saving in power of 15 to 20 per cent, with a considerable saving in maintenance costs and improvement in the quality of the product. As the result of this showing all of the 27 machines have been changed over to automatic control.

3 Electron tube control was applied by a manufacturer of V-belts to a small d.c. motor in order to insure constant tension on the cords used in making the belts. The quality of the product was improved and the savings that have been made by the reduction in the number of shut-downs amounts each year to many times the cost of the installation.

4 Power consumption of nine traveling cranes in the foundry and machine shop of an Eastern manufacturer of heavy machinery was reduced about 25 per cent by replacing the controllers. The cranes originally were equipped with a conventional dynamic system of lowering control. The new controllers make possible higher speeds and more accurate control while lowering the load. Power peaks are reduced and when heavy loads are being handled more power is returned to the line.

5 In an Eastern metal-working plant automatic control of the factory lighting system by phototubes has reduced power consumption between 4,000 and 5,000 kw.-hr. a month, cut lamp replacements about 25 per cent, and increased output. The intensity of illumination in all areas is kept always at the desired value, but since full advantage is taken of natural daylight the lamps are burned only when necessary. As soon as daylight gives the required light intensity the lighting circuit is switched off through relays that are controlled by the phototubes.

6 A resistance welding machine used in the plant of a Mid-Western manufacturer for welding the bottoms of steel pails originally was equipped with a mechanical current interrupter. This device required overhauling every day. Output of the welder was about 200 pails an hour. An electron tube control increased the output of the machine 50 per cent, to 300 pails an hour. Maintenance costs practically have been eliminated, since the new control requires no attention.

7 Action of corrosive gases on exposed controllers in the producer-gas plant of a Mid-Western steel mill caused many shut-downs and high operating and maintenance costs. Eventually a few of the old controllers were replaced with new models inclosed in dust-tight steel cabinets. At the end of six months, during which the equipment had received no maintenance attention, an inspection disclosed no signs of corrosion or wear. Thereupon all of the old controllers still in

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AN ELECTRIC motor represents brute force, working blindly. In the absence of some means of protection it will wreck or burn itself out if conditions become sufficiently abnormal. There must be some means of turning the current on and off, disconnecting it from the supply line when current flow becomes excessive because of overloads or defects, and performing other functions that are needed for safety and proper performance. It is the duty of control equipment to provide these functions.

Controls range in complexity from a simple switch for starting a small motor or turning on a lighting circuit to sizable panels containing the many devices needed for the automatic starting and protection of a huge synchronous motor. Roughly, they may be classified as manual and magnetic. Functioning of manual control is initiated and governed through the manipulation of levers or

use were replaced with dust-tight equipment. The savings in operating and maintenance charges will help materially in paying the cost.

8 At an Eastern mine the mechanically operated switches employed to open the mine doors when a train of cars approached and close them after it had passed, were the cause of much trouble and delay. Maintenance costs on these switches were high. The troubles and delays stopped, and with them practically all of the maintenance charges, upon the installation of a door-opening mechanism controlled by a phototube.

9 Bells of the blast furnaces in a Mid-Western steel mill originally were operated by steam-driven pistons controlled by the operator of the hoist that carries the charge to the top of the furnace. Manual control of the pistons was replaced with automatic electrical control. The cost of the automatic control was about $1,500. Savings in labor costs alone are estimated at $5,000 a year, which amounts to a gross return of 333 per cent on the investment.

10 An Eastern sheet and tinplate mill solved the problem of securing low maintenance costs by installing oil-immersed, dust-tight starters for a battery of sheet-metal slitting machines. High frequency of operation and the presence of acid fumes and mill dust make the service severe, but maintenance of these starters has cost nothing during the two and one-half years they have been in operation.

11 A large manufacturer of a bulk material that is sold in small packages has made substantial savings by installing automatic scales equipped with phototube control so that the flow of material into the packages is cut off immediately when the desired weight has been reached. Under-filling of packages has been eliminated; the material formerly lost through over-filling is saved.

12 Capacity of a lifting magnet used in an Eastern steel mill for handling ingots was increased considerably by the installation of a new controller. Formerly the load on the magnet was released by a controller that had three positions: lift, off, and drop. With the controller that was used originally the ingots did not drop until six or seven seconds after current was cut off. Now they drop within three seconds. Less manipulation of the new controller is required because one function has been made automatic.

13 Installation on a lamp and radio bulb machine in an Eastern glass plant of a motor controller using electron tubes cut costs and put an end to several troublesome problems. With the new control any motor speed from standstill to full speed can be obtained easily and without waste of power. The old control required considerable maintenance attention and renewal of parts; these costs have been eliminated.

14 In an Eastern plant manufacturing food products trouble was experienced in cutting the waxed paper in which some of the packages are sealed. It was impossible to avoid slippage or creepage of the paper while passing through the feeding rolls, with the result that the printed matter appeared in various positions on the package. The problem was solved by the installation of a phototube control that governs the rate of feed so closely that the paper is cut within $\frac{1}{16}$ in. of the proper place.

15 Replacing mechanical switches that were the cause of considerable trouble, a phototube control for a sheet catcher in a large steel mill has decreased operating and maintenance costs and increased production. Frequently damaged, the old switches required much attention and delayed production. The new control makes it possible to eliminate one or more men on a stand of rolls.

16 Exposed control equipment was the cause of much expense and trouble in a Mid-Western packing plant. Moisture and organic acids caused rapid corrosion, which resulted in frequent breakdowns. Following replacement of the old controls with equipment enclosed in moisture-proof housings the former troubles disappeared. The practical elimination of maintenance costs alone will pay for the new equipment within a short time.

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other parts. With magnetic controls functioning is initiated and governed by manipulation of a push button or similar device. The main switches, termed contactors, and other devices are operated by electromagnets. Control is considered to be automatic when its functioning is initiated and governed by some impersonal influence.

Magnetic and automatic controls are to be preferred in many cases to manual control because in addition to saving the operator's time removal of the human element eliminates the possibility of damage to the equipment through ignorance or carelessness. They also make it possible to control equipment that is located at a distance from the operator.

As machines have become larger, more complicated, and more specialized the duties imposed on the motors and control equipment have likewise become much more exacting and important. Development work on controls has kept pace with, possibly exceeded, the increasingly severe demands that have been placed on such devices.

The foregoing discussion applies primarily to conventional controls whose functioning is based on electromagnetic devices. Within the past few years new forms of control that have already wrought important changes have been made available. They are based on the action of electron tubes, of which the ordinary radio tube is a familiar example. Many important applications of these controls involve the use of the phototube or photoelectric cell.

Electrical control equipment is available that can function in practically any desired way to accomplish almost any desired purpose, under any atmospheric conditions. It offers many opportunities to lower operating and maintenance costs and increase production by increasing the efficiency, reliability, and safety of machine operation.

One of Power Transmission's Milestones . . .

The Geared Motor-Reducer

Paul W. Arnold

Development Engineer
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Cleveland, Ohio

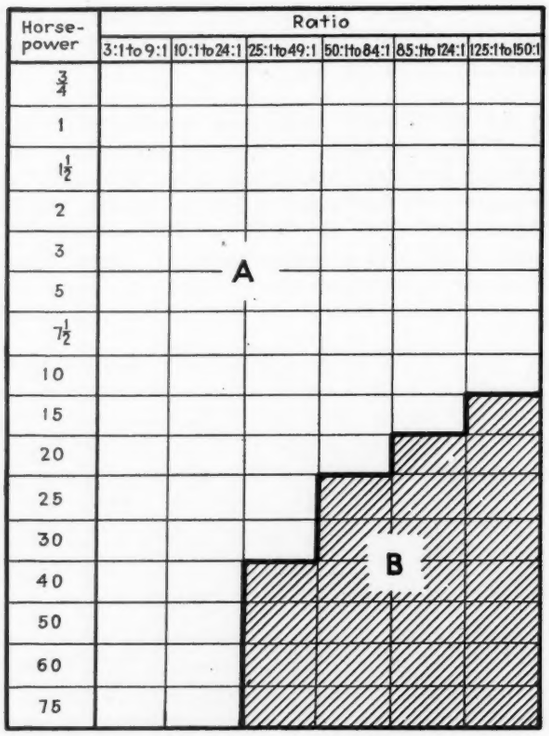

Figure 1—If the desired horsepower rating and reduction ratio fall in area *A* it is probable that the first cost of a geared motor-reducer will be less than that of a separate motor and speed reducer. When the horsepower and ratio fall in area *B* the costs will be about the same, or the motor-reducer may be slightly higher

INDUSTRY has found and is rapidly adopting a new piece of power transmission equipment—the combination of a speed reducer and an electric motor, built as a single unit. Speed reducers were developed as separate, inclosed units because of the need for something better than open gearing. To combine a separate speed reducer with a source of power it is necessary to mount the two units on some sort of a base and connect them with a flexible coupling. The combination unit eliminates the sub-base and intermediate coupling, and the necessity of mounting and lining up two units.

The advantages of the geared motor-reducer over the separate units may be concisely stated as:

1. Lower first cost.
2. Lower installation cost.
3. Less floor space required.

There may be other minor advantages but these three are of such importance that they cannot be disregarded. The savings possible must be considered in new power drive and machine layout projects, in the design of new equipment, and in the modernization of old equipment.

It is impossible to give a definite comparison of the first cost of geared motor-reducers and the cost of separate reducers plus motors, bases and couplings, because of the wide variation in the types that are on the market. Any general statement that is made can be disproven at least in part. However, to give a rough idea of comparative first costs the chart shown in Figure 1 has been prepared. If the required geared motor-reducer falls in area *A* it is fairly safe to assume that it will be lower in first cost than the separate units. If it falls in area *B* the costs may be about the same or possibly slightly more for the geared motor-reducer.

The geared motor-reducer prices used in making this comparison are a fair composite of the published prices of several types. This price has been compared with the average price of conventional herringbone or helical speed reducers plus a fair addition for the base, coupling, and mounting. If the comparison had been made against worm-gear reducers it is quite possible that for small units and low ratios an occasional saving might be shown for the separate units. If estimates are to be made with absolute certainty the actual prices of the separate and combined units must be compared.

Installation cost of a geared motor-reducer is lower than that of separate units. Since it is delivered as a complete unit, the installation cost is about the same as that of a motor alone. Separate motors and speed reducers may be received completely assembled and mounted on a base, but when installed a more elaborate foundation is required. It is also desirable to check alignment and correct any error that may have been caused by shipment or improper installation. If the units are received separately the installation work and cost are greater.

It is as difficult to give definite figures on space saved by geared motor-reducers as on first cost, because of the variations in construction and design of both the combined and the separate units. A fair average, however, would be about 25 per cent. Frequently the difference in the shape of the space required works out to the advantage of the geared motor-reducer.

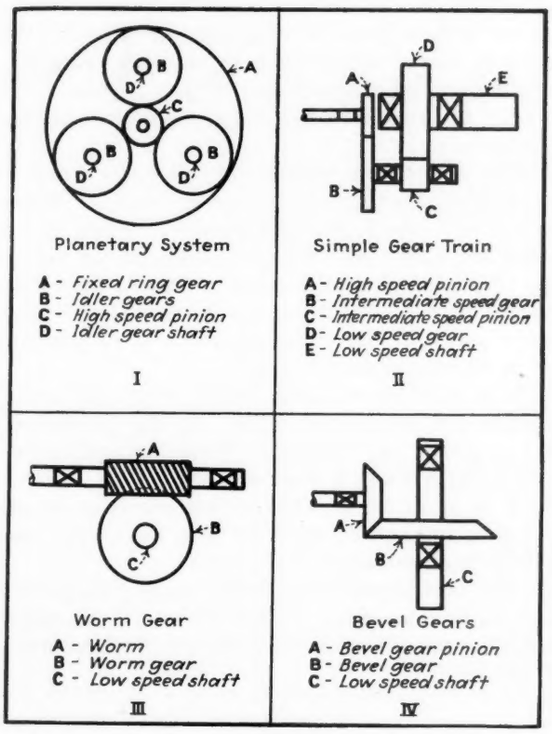

Figure 2—Gears may be arranged in several different ways in reduction units, including geared motor-reducers

▶▶ Speed reducers and motors, once neighbors, now live under the same roof. The combination frequently means lower purchase and installation costs, less space. Suitable for direct connection, belt or chain drive, the geared motor-reducer will make easier the solution of some power drive problems.

Geared motor-reducers now on the market can be divided into four general groups that are described as:

1. Planetary gear system.
2. Worm gear.
3. Simple train of gears.
4. Miscellaneous combinations.

The planetary gear system, Figure 2, diagram *I*, consists of a high-speed driving pinion in contact with three idler gears which in turn mesh with a fixed ring gear. The idler gears are carried on a plate or cage that either carries the low-speed output shaft or, if it is a compound unit, the high-speed pinion of the next stage. The reduction for each stage may be determined by dividing the number of teeth in the pinion into the number of teeth in the ring gear and adding 1.

To eliminate the necessity of using small, high-speed pinions the ratio preferably should be limited to 8:1 and should not be more than 10:1 in each stage.

The planetary gears fit into a round housing similar in appearance and size to a motor. The low- and high-speed shafts are concentric and large reductions are possible in a small space.

In the early models of geared motor-reducers the use of the simple train of gears was avoided for ratios above eight or nine to one. Later, several manufacturers worked out simple gear trains that fitted into the requirements.

In simple gear trains, Figure 2, *II*, a high-speed driving pinion meshes with an intermediate gear. A second pinion is mounted on the intermediate gear shaft which in turn drives into the low-speed gear. For higher ratios the train may consist of five or six gears.

A geared motor-reducer using a simple train of gears may or may not have a slow-speed shaft concentric with the motor shaft. The ratio of reduction is directly proportional to the number of teeth on the pinions and gears. Figure 3 shows a typical unit.

Worm gears, Figure 2, *III*, provide a low-cost and rugged means of speed reduction. Efficiency is generally low, and many units are designed to be self-locking. In small sizes and for low ratios the worm gear has been used successfully in geared motor-reducer units. The low cost of the worm and gear make possible a low over-all cost which has led to this combination.

Under miscellaneous combinations are put bevel gear units (Figure 2, *IV*), combinations of bevel and spur gears, and combinations such as semi-planetary systems using only two idler gears.

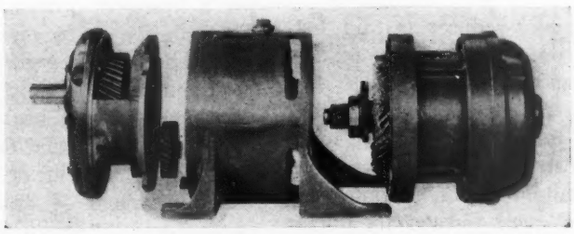

Figure 3—Looks like a relative of a jigsaw puzzle picture, but it's merely a geared motor-reducer before final assembly. A simple train of gears is used in this unit

There are two types of motor-reducers on the market that do not use gears. In one rolling surfaces arranged in a planetary system are used. In the other unit the high-speed pinion is replaced with a cam that forces pins into an angular rack, so that a slow rotary motion is obtained.

Two general types of mechanical construction are used in combining a motor and a speed reducer:

1. Wherein the motor carries the gear.
2. Wherein the gear carries the motor.

Recent designs seem to favor the latter construction, particularly for units with ratios of more than 10:1. For lower ratios either design may be used. It is believed by many users that motor-supporting parts which normally are subjected to relatively low torques are not of ample strength to withstand the increased torques at

lower speeds. Roughly, a 5-hp. 1,800-r.p.m. motor develops 14.5 lb.-ft. torque at 1-ft. radius. If the output speed is reduced by 10 to 1 the torque is increased 10 times or to 145 lb.-ft. If the ratio is 100:1 the torque is 1,450 lb.-ft. and it becomes absurd to consider transmitting such a torque through motor parts designed to carry 14.5 lb.-ft. torque.

Practically all geared motor-reducers are built with anti-friction bearings throughout. One of the principal reasons for their use is the greater capacity obtainable in a limited space. Also, most units use helical or other types of gears such as worm or bevel that produce thrust as well as radial loads. These thrust loads may be supported easily by either ball or roller bearings.

Lubrication of bearings and gears is in general accomplished by the splash system. That is, part of the gears run through the lubricant and splash or throw it on the other gears and on all bearings. In the case of geared motor-reducers built for vertical operation force-feed lubrication usually is necessary.

Every manufacturer of these units will recommend the lubricant best adapted to his design and the operating temperature. It is best, of course, to follow the recommendation of the manufacturer or of reputable refiners. The lubricant to be recommended will depend on the temperature in which the unit will operate, as well as the features of its design. One good rule to follow is to make certain that the proper amount of lubricant is used. Cleaning and refilling annually, or as often as needed, will also pay for their cost in lengthened life and fewer breakdowns.

Ratios from 2:1 to 250:1 are standard with various manufacturers of geared motor-reducers. Ratios much higher than these are obtainable by combinations of two units. When investigating units that give very high reductions in a limited space at low cost it is always well to check bearings and other mechanical parts carefully to see whether they will withstand the torques developed.

When selecting a geared motor-reducer certain features should be investigated from the standpoint of first cost, installation, and maintenance. For example:

1. It should have an adequate supporting structure. Because of the low speed the torque that must be withstood by the supports is equal to the motor torque times the ratio. If the feet normally built on a motor are required to withstand the low-speed torques the factor of safety in their design is being encroached upon. With low ratios this construction may be good practice; at least the trend in design points in that direction. This is a point of prime importance and should be considered very carefully.

2. The maintenance department will desire a unit that may be assembled and disassembled easily. When a motor is built into a gear unit provision should be made at least for easy removal of the stator or the field coil ring. It should also be possible to remove the rotor or armature without disturbing the gears. If this cannot be done much of the saving in first cost may be spent later in high maintenance costs.

3. It is desirable to have units in which the ratio of reduction can be changed easily. It may be desired to move a geared motor-reducer from one application to another that requires a different ratio.

4. It is of prime importance that provision be made to prevent leakage of lubricant into the motor, which would soon cause failure.

5. The unit should have ample bearing supports for direct connection, chain, or belt drive. In the desire to conserve space, there may be instances in which bearings will be slighted.

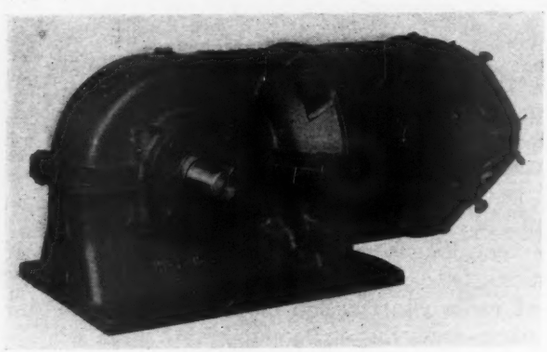

Figure 4—A spiral bevel gear and pinion are used in this geared motor-reducer to give a right-angle drive

Lime-Soap Grease for Lubrication

THE ARTICLE "Electric Motors, Lubrication and Life Extension" by Prof. Clower, on page 41 of the February issue, is timely and should be of wide general interest, since it sets forth some very excellent principles to be followed in the lubrication of motors. However, I take exception to the recommendation to use a lime-soap grease at temperatures up to 140 deg. Fahrenheit.

In the past lime-soap greases have been recommended for the lubrication of integral horsepower sizes of motors using anti-friction bearings. Nevertheless, where such greases are permitted to stand unagitated for some time in a bearing housing or in contact with the raceways and balls or rollers of anti-friction bearings the result is invariably a hardening or oxidation which produces such a quantity of small, hard particles that in many cases the rotor or armature is blocked, so that it cannot be turned by hand, or accelerate under its own power. For this reason the tendency seems to be for most grease manufacturers to recommend the use of a soda-soap-base grease for all general-purpose applications.

It is recognized, of course, that a soda-soap grease is soluble in water, but with the average design of motor and in the average application moisture is not a sufficiently important factor to warrant the use of a lime-soap grease for that reason alone, in view of the danger of the oxidation and hardening of such a lubricant. I fear that trouble would result if the recommendation to use a lime-soap grease were generally followed.

F. E. HARRELL.
Engineering Department
The Reliance Electric & Engineering Company
Cleveland, Ohio

· FACTORY FORUM ·

A new question is presented herewith, and readers' discussions of previous questions are published. Write down your opinions and send them to the editor. Answers published will be paid for

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What Is the Plant Man's Responsibility Toward Sales?

Frank Fulleger and George Shipman have met at lunch. We arrive at the adjoining table after the soup course, which has been disposed of in silence, so far as conversation is concerned. But with the entree, Frank opens up.

* * *

"I'm elated today, George" says Frank. "I find that I'm a business man."

"Oh yes? Since when, and how come? Thought you were a plant man."

"So I am, but I find that I'm also a big influence on the sale of our product, and I choose to claim that makes me a business man. Rather far fetched, maybe, but I enjoy exercising the imagination once in a while."

"All right, Frank. Now that you've had your fun, what's it all about?"

"Just this, George. There was a live-wire salesman in to see me yesterday. Straining as I am under 'don't buy' orders, I tried to block him right off—being polite and all that, you know—by telling him that we're buying only absolute necessities and few of them and that we'll continue along those lines until business picks up.

" 'Same old story,' says he, and then goes on, 'Being somewhat of a philosopher, and having heard that you are the same, I'll forget that I'm trying to sell you something, and have a friendly discussion with you on that point, if you will.'

"I agree, being half ashamed of my attitude by that time, and tell him to shoot. Here's about what he said: 'Mr. Fulleger, I feel that you plant men have a serious responsibility for the sale of the products your plants make. If you're like most people, you've asked yourself how old man Soandso can turn out a six-cylinder automobile better in every way than the four he offered last year, and sell it for less money. And you've wondered how come you can buy furniture at half 1929 prices, shoes at 70 per cent of the old recognized prices, and so on and so on—and you can't see any less value in these lower priced products.

" 'Right there I think you ought to go a step further and recognize that behind the new prices for the old values there has to be a plant force that figures out economies in making the cars and the furniture and the shoes—economies in methods and equipment.

" 'Every economy brought about in the thin producing load of today makes the position of the sales forces just that much stronger. So I say that sales begin in the plant, with the plant men, and I conclude that there is a fine responsibility for more sales and therefore better business on the shoulders of the men holding jobs like yours.'

"I haven't given you all the details, George, but that's fairly close to the way he put it. So you see why I say I'm a business man."

"Congratulations on your new standing, Frank. Wonder how I rank on that basis? Theory sounds pretty good, too. Have you tried it out on anybody else?"

"No, but I'm suggesting to you right now that you consider it for discussion at the next meeting of our plant operating group. I'd like to hear the thing discussed by a lot of fellows—from little plants as well as big ones. Might be able to bring my salesman acquaintance along."

"Fine—I'll put the idea into the form of a question and send out the notices. What you having for dessert —pie or ice cream? I'll have another coffee, too—."

* * *

We conclude that the discussion is over, pick up the check and depart, feeling that we've been on the inside of a very interesting tableau, and anxious to seek the opinions of FACTORY MANAGEMENT AND MAINTENANCE *readers. So here you are:*

What Is the Plant Man's Responsibility Toward Sales?

Answers to previous questions begin on the following page

Should Maintenance Be Consulted in the Design of Special Machines?

(Question presented in the January issue)

IN MY opinion, the maintenance angle should not be overlooked in designing machinery for use in the plant, or for sale. Therefore, it is sound practice that the maintenance engineer be given an opportunity to pass an opinion before the design goes into production. By so collaborating with the designer, the maintenance engineer—by reason of his practical operating experience—can bring to light those defects which often pass unnoticed on the drawing-board, yet detract in an irritating and costly manner from satisfactory performance.

Among several items which the maintenance engineer is competent to advise upon are these: power application; installation; lubrication (on which the life of the machine depends and which cannot be profitably entrusted to hit-or-miss methods).

Then there is accessibility. I have in mind, as an example, an old type of compressor which had to be almost dismantled in order to replace a bushing which cost only a few cents.

I was connected with a concern which designs and builds special machinery for every phase of wire production. The maintenance engineer, also in charge of the machine shop, was associated in the design of a heavy wire-drawing machine, which proved successful except that the dies, because of the increased speed, wore out too rapidly. It was the maintenance engineer who suggested the use of tungsten carbide, which proved successful as to long life and high-quality wire.

ROBERT S. ALEXANDER, *Special Department Universal Winding Company, Providence, R. I.*

IT IS not an absolute necessity for the maintenance department to be consulted in the design of special machinery. It is possible for all work to continue smoothly, without such consultation. However, the consulting of this group may result in a much better system, will insure a complete and accurate knowledge by this responsible group, and in no possible way can it do harm. The consulting of the maintenance engineer does not cost extra, advice may be heeded or disregarded, but it's always wise to remember that two heads are better than one.

The maintenance engineer is aware of just how well a new piece of machinery will fit in with the general arrangement of the plant. He knows that one type can be used to great advantage, whereas another type may conflict with what is already installed, and necessitate a radical change which will run into large money.

There is still another reason why the maintenance head should be consulted. He is responsible for the well-being of the entire plant. It is up to him to see that everything is in running order, and to keep it that way. It is only fair that he should know just what new devices are being considered for installment, so that he can be deciding just where the best place for them is, and how to keep them in tip-top condition. He may be unfamiliar with the new model and wish to look into its construction a bit. It is the height of the ridiculous for him not to be given an opportunity to acquaint himself with the piece of machinery for which he is to be held responsible.

The reasons given indicate that he should also be consulted in the making of special machinery for sale. He understands how the other maintenance engineer will be affected. WILL HERMAN, *Superintendent Tanenbaum Oil Company, Cleveland, Ohio.*

THROUGH practical experience in the field much is learned by the maintenance and servicing department regarding the efficient design of plant equipment. It should be almost standard procedure to consult this department with regard to design from a practical viewpoint. Such procedure will ensure a final design that will result in lowest ultimate cost. Lowest ultimate cost must take into consideration the entire life of the equipment; hence simplicity as regards maintenance and servicing is of vital importance.

To illustrate: Too often the power transmission side of equipment is not given enough thought in the course of design. Sometimes the power auxiliaries are unsuited under the unavoidable operating conditions.

Not infrequently salvaged parts and supplies on hand can be economically incorporated. Consultation with the department familiar with such materials means lowest cost fabrication.

Too much emphasis cannot be placed on the importance of adequate and convenient means of lubrication. Those not close to the maintenance and service end, regardless of engineering and designing ability, often lack complete understanding of lubricating problems and solutions.

Consultation with maintenance many times results in a better understanding as to the accuracy required and tolerances that must be held. Tolerances that are too close mean needless cost in making the equipment; tolerances too loose mean needless cost in operation.

Special equipment in many cases has a bearing on neighboring auxiliary equipment, requiring alterations or preparation. With a knowledge of what to look forward to pre-planning is possible. Last-minute rush work of this nature is always costly. H. L. SCHULTZ *Assistant Superintendent of Maintenance Carborundum Company, Niagara Falls, N. Y.*

WHEN a repair of any importance must be made the men in charge of maintenance are asked: How long will the machine be out of service? What will be necessary in the way of supplies and parts? What will the job cost?

It is with loss of production that management is most concerned. Never mind how difficult the job is made by grease, dirt, and complicated conditions. Let the foreman in charge worry. Had this foreman been consulted when the machine was designed a different story might be told. Hours might have been saved had the engineering department taken the maintenance department into its confidence.

Under certain conditions parts subject to abrasion and wear break down. No man is better acquainted with these conditions than the man who must put the equipment back on the job.

Modern shops, tools, and overhead cranes are not always found in the field, as they are in the factory

where the equipment is designed and manufactured. The maintenance department appreciates this fact more than does any designing engineer or high-powered salesman.

Nine times out of ten, when things go wrong, some one passes the buck until the maintenance department shoulders the blame. So why not give it a little break in design?

DALE BRYSON, *Master Mechanic*
New Haven & Dunbar Railroad, Dunbar, Pa.

Can the Stripping of Idle Machines Be Justified?

(Question presented in the November issue)

THE STRIPPING of idle machines in times of depression can conscientiously be done, provided the executive in charge does not allow it to be carried to extremes. Such a policy should be sponsored only by one in authority and action taken only upon his personal approval. Obviously this man should be one not only familiar with operating problems, but in touch with the trend of business.

As a matter of consistency in ordinary conditions, stripping is not recommended, although it has advantages at all times. However, at the present time, superintendents, when wanting parts that are needed, are economy-minded enough to realize that almost any piece of equipment being unused today is liable to be unused for some few months to come. No need to order new equipment, they say, when satisfactory parts are just forty feet away, idle now, and perhaps idle for the preceding year. Idleness does not necessarily mean deterioration, but very few things improve with age, and machinery is not one of them.

A factor in one plant in the middle west is the time necessary to allow for new parts. Executives here have found it much more practical to strip one or two embossing presses to keep four others in repair rather than order new parts for all six as they fall by the wayside. They have found that in these presses the manufacturers have practically no parts on hand and are making them up as orders come in. This results in four to six weeks' delay.

The answer as to whether stripping can be done without its harmful effects being felt lies with the executive in charge. If this man is alert enough to sense the time to have the stripped machines brought to usable condition, he is not going to suffer the penalty of being under-equipped when the time comes.

In a printing plant in Kansas City two out of ten printing presses needed considerable repairs. At the time they were shut down it was decided that business prospects were of such a nature that they would not be needed for some months to come, so it was decided not to spend the $300 necessary to bring them up to par. As time went on business got no better and, still wanting to spend only the most necessary money, it was decided when the other presses needed parts to strip the two not working. This was done.

Sales the last two months, coupled with a change in designing, indicate that by midsummer the pressroom will be working to capacity. The operating manager, sensing this, asked for estimates from outside machinists for overhauling the two presses. Much to his surprise, and pleasure, the price he obtained was only $240, which even included some of the parts that he had taken since the estimate of $300 was given.

The repairs were of such a nature that the work could be done at different times with almost no additional cost so, in order to spread out his expenses, he bought some of the missing parts one month, the balance the second month, and is having the overhauling done over a three months' period, thus spreading out his payments over a five months' period, finishing in time, he believes, to be ready for his peak load. While most places cannot hope to have such a fortunate condition, here, at least, is one man who is making the practice of stripping a profitable one.

Stripping is a thing to be done under ordinary circumstances in emergencies only. It only delays the inevitable and is likely to bring more damage in decreased capacity than the small amount of money that could possibly be saved by delay.

C. S. STEVENSON, *Operating Manager*
Hall Brothers, Inc., Kansas City, Mo.

OF ALL the feats of seamanship which skippers love to boast about, that of coming into port through a gale with all gear intact takes pride of place. So the command to "lighten ship" is given only when it cannot humanly be avoided, because the skipper knows that when he reaches port the aforesaid gear will have to be replaced at a cost of time and money that will eat into the profit of his voyage.

Which is one way of stating the maintenance man's position in regard to stripping idle machines. Sooner or later—and all the signs predicate the former—these stripped machines will again be called into service, with the possibility that rush orders will be delayed while the parts are replaced—in the face of a rising market.

The practice of stripping idle machines must also be decried from the national viewpoint; such a policy is certainly not going to lessen the burden of unemployment. Apart from this angle of the situation, there is the damaging effect on employee morale. It is strangely discouraging to work in a shop where a proportion of the machines is idle; it is still more disheartening to see those machines being gradually dismantled because of short-sighted economic reasoning on the part of management.

While it is a known fact that several railroad shops have been remiss in this respect, which probably accounts for the recent recall of thousands of their machinists, the small manufacturing establishments have maintained a high level of equipment and maintenance efficiency. One shop I visited recently, which has operated on a part-time basis for almost two years, had indeed installed a new and expensive machine tool. When I commented on this, in the course of a conversation with the owner, his answer was illuminating: "I could not afford to be without it." Which probably reflects the indomitable spirit that is pulling the country out of the slough of despond.

ROBERT S. ALEXANDER, *Special Department*
Universal Winding Machine Company
Auburn, R. I.

Pipes MAPPED *Are Pipes* FOUND

►► Plant pipes are perverse enough to do most of their bursting in the dead of night. If you can't help that, at least you can know where manholes and shut-off valves are located. Chart them so they can't get away from you. It's an *ideal* job for slack time—a *good* job for any time

Fred D. Hartford

Denver

AT 2 O'CLOCK on a cold January morning the telephone got the new master mechanic out of bed. A forlorn voice at the other end of the wire said:

"That big water main in the middle of the plant just blew up and the yard's flooded. What'll I do?"

The one employee who knew where all the manholes and the shutoff valves were located, lay seriously ill in a hospital and could give no help.

The master mechanic, on his arrival at the plant, immediately dropped the water pressure just as low as the water jackets on one of the furnaces would allow. Then in the cold gray dawn he organized a grand hunt for manholes and shut-off valves over several acres of ground covered by a fast thickening layer of ice. Obviously it was necessary to isolate the broken pipe and at the same time allow the plant to run. About noon of that day, after half a million gallons of water had flooded the plant, and after the yard had been so torn up that it looked like No Man's Land, the necessary valves were found.*

Later, when everyone who had any responsibility whatsoever for lack of records about underground piping had been thoroughly criticised, the prosaic job of getting suitable maps and records was started.

Every seasoned plant man is periodically brought face to face with the necessity for knowing just where underground piping is located. However, the matter of getting adequate records usually is put off "until the next slack time." Even though a plant has piping records, it frequently does not keep them up to date, likewise awaiting that slack time.

A plant underground water-piping system starts out by being simple and direct, but it becomes intricate from the changes and additions that inevitably follow a period of

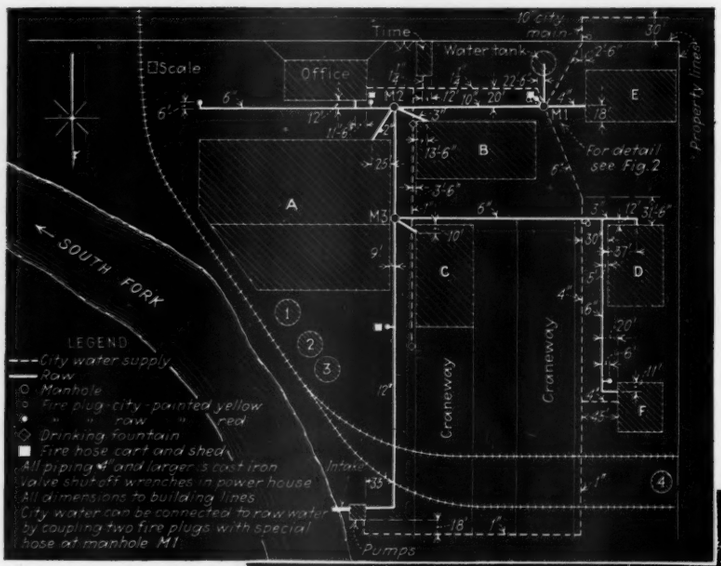


Figure 1—Map of water lines only.

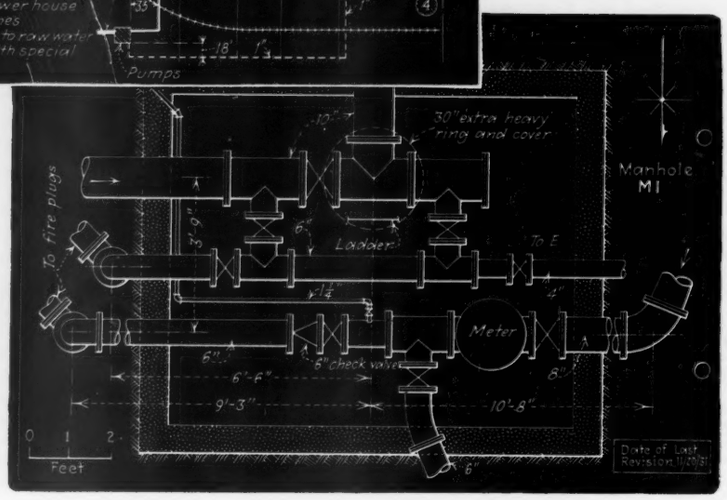


Figure 2—Specimen notebook page showing a valve chamber denoted by one of the symbols of the water map, Figure 1.

*Uncharted underground piping sometimes can be located by means of magnetic or electrically operated instruments.

years. Further complicating the records, most plants have two water systems: one, the city or filtered water supply; the other, the raw water or unfiltered supply. These two systems usually are shown on a single map since they can be made readily distinguishable by various artifices known to every draftsman.

The preceding paragraph brings up the question whether the various plant services —water, sewers, compressed air, steam— should be shown on a single map, or whether each service should have its own map. Each of the two systems has advantages and disadvantages.

If the plant is small, if the piping is relatively simple, and if the map can be made to a scale of good size, say 1 in. equals 20 ft., then all piping can be shown on one map. This scheme has the advantage of immediately indicating any conflict of existing lines with proposed extensions or with changes in any other service. The disadvantage of a single map is that, as the plant grows, the map becomes so complicated as to be thoroughly confusing. In addition, the map becomes illegible from erasures and handling. An advantage of one map for each service is that each map can be smaller and at the same time allow more complete information to be put on it.

A typical map giving only the water lines is shown by Figure 1. Figure 2 illustrates a specimen notebook page showing a valve chamber denoted by one of the symbols of the water map. For field use, the large map is often reduced to notebook size by the photostatic process. Incidentally, such maps should be made accurately to scale, because one of their principal uses is the sketching in and scaling of changes and additions. The value of blueprint reproductions of piping maps can be greatly increased by coloring the lines of the piping with brilliant and contrasting colors—a simple, effective adjunct.

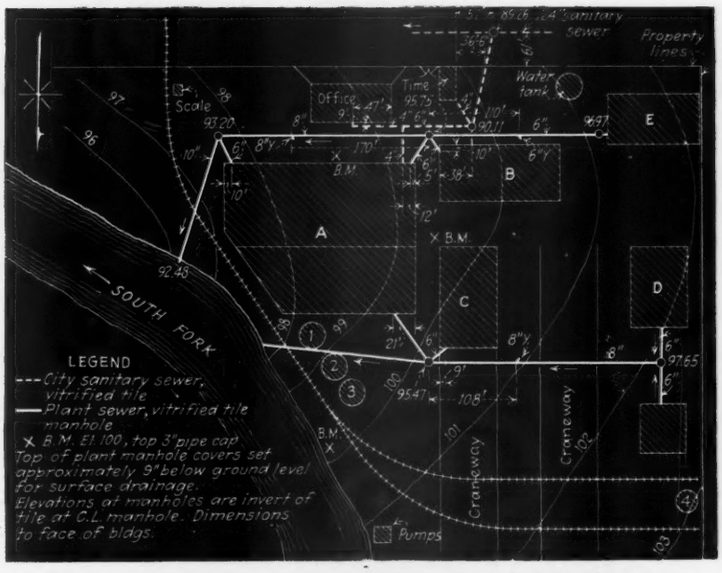


Figure 3—Map of sewer piping. Note that the "Y" joints for future connections are carefully dimensioned.

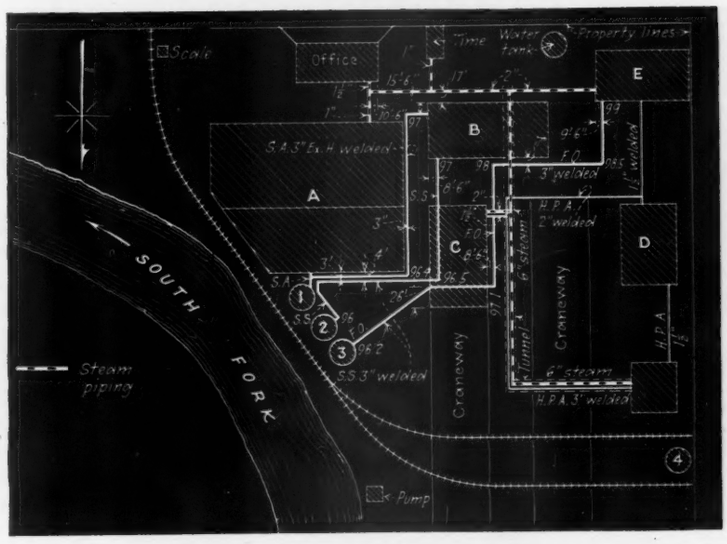


Figure 4—Map of miscellaneous piping.

Many of the points that have been brought out about water piping apply equally to maps for sewers. In addition, the sewer map frequently shows the ground contour lines since they aid in planning extensions to sewers to fit the lay of the land. The liberal use of elevations for sewers—manholes, at the outfalls, and at various plant units —is also desirable for planning extensions. Note in Figure 3 that the "Y" joints for future connections are carefully dimensioned.

The sanitary sewer and the plant sewer are distinguished by dotted and solid lines respectively. It is assumed that the building drawings show the sewers inside the buildings, as they should also indicate the water, air, and steam piping. The sewer pipe map is supplemented, of course, by other detail drawings of the manholes and outfall wing walls.

Because these services usually are simple, they can be combined on one map without undue complication. Since these lines should all drain, the elevations with reference to a bench mark are important figures. Figure 4 shows a map with notes pertinent to these services.

As an aid to locating various underground pipe lines, some maintenance engineers paint an arrow on the side of a building directly above the point where a pipe line enters it. Another device is a stencil on the side of a building or on the face of a curb, giving the dimensions and direction to a pipe line, valve, or other fitting. However, since accident or weathering may easily obliterate such marks, they should not be regarded as substitutes for accurate notes and maps.

Another use for records of underground piping is for appraisal. The man who is evaluating the physical assets of a plant is almost wholly dependent on the records and maps for such items. Only complete and up-to-date information will lead to equitable evaluation. This may not be an unmixed blessing so far as assessment for tax purposes is concerned, but it is valuable when a plant is being appraised for a sale or a merger.

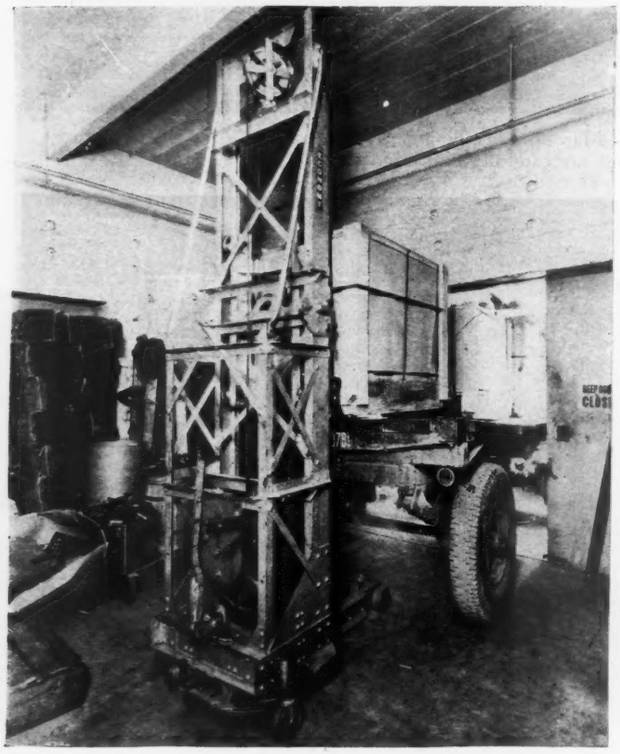
·MAINT-O-GRAPHS·

Equipment efficiency • Ideas • Plant problems • Design developments

Tiering Machine Unloads Trucks

Unloading 1-ton boxes on skids from a truck is one of the jobs of a 2-ton, transfer-type, portable tiering machine in the plant of the Gulf Publishing Company.

To operate, the lifting arms are pushed under the skid



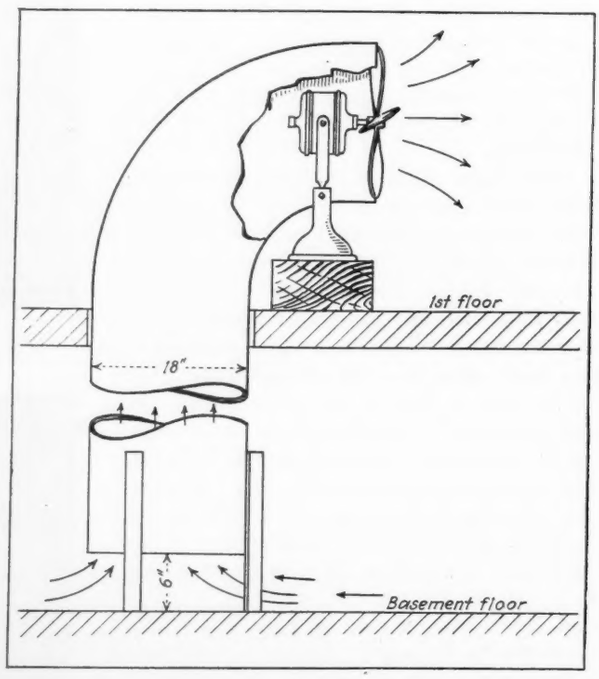
as shown, the load is lifted clear of the truck and, after the machine has been moved back to clear the truck, the box is lowered.

Drying a Basement

Geo. P. Pearce

There was a good sized basement under part of the foundry in which core sand was stored. This basement was very damp and the ventilation through a couple of cellar windows and the sand chute did practically no good, the cool heavy air staying below these openings. Some changes in production methods scheduled a couple of men to work in this place and something had to be done promptly to make it more comfortable.

The plant engineer installed an 18-in. pipe to reach from the basement floor to about a foot above the foundry floor and fitted it with an elbow and an 18-in. electric fan as shown. The pipe passes through planking that covered a disused elevator shaft in the ceiling of the



basement. Three pieces of 1¼-in. angle iron bolted to the pipe keep the lower end 6 in. above the basement floor, so that only the coldest air is withdrawn.

A week later quite a considerable difference was noticed in the basement and within a month everything down there was dry and comfortable.

Smoke for Testing Air Currents

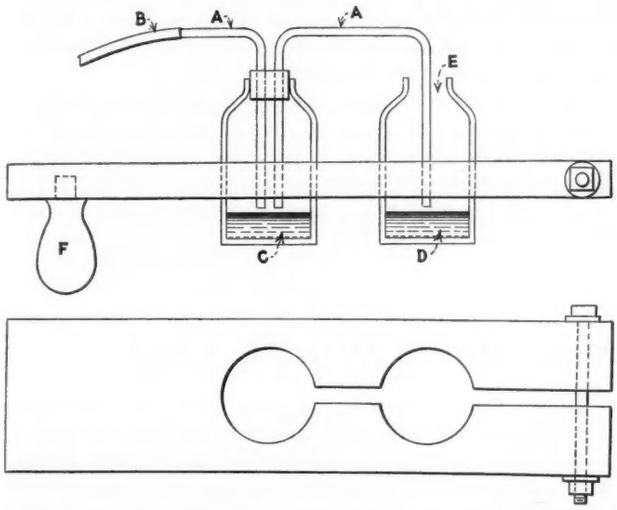
John E. Hyler, Peoria, Ill.

It has long been common practice to use smoke in the study of air currents in order to obtain the desired movement of the air. This method is used for studying stream-lining of objects or for determining how to place fans or baffles.

But the practice has been changing in one respect: where the smoke once was obtained from an actual fire—burning old rope or some other material—the fire hazard now can be eliminated entirely because a smoky vapor can be produced by chemical means. Although not real smoke, it is better than smoke. Because of its warmth, smoke tends to travel upward. Vapor chemically produced, therefore, will indicate existing air currents more faithfully, for it does not rise unless it is carried upward by a rising current of air.

If you need smoke for testing the movement of air in drying kilns or for checking the air currents in connection with a heating or ventilating system you will be

interested in constructing the smoke maker illustrated. Two bottles, mounted on a common base or clamped in a common holder, are shown as *C* and *D*. They are connected by a piece of glass tubing *A*, bent as shown. From the first bottle, which is corked, a second piece of glass tubing *A* extends forward, and a length of rubber



tubing, *B*, is secured to it. The handle, *F*, may be mounted in a hole bored in the clamp board as shown. The bolt in front should be drawn just tight enough to hold the two bottles firmly.

In the first bottle at *C* is muriatic or hydrochloric acid whereas, in the second at *D*, is strong ammonia. The fumes of these two liquids combine to form a dense vapor. When the rubber tube is blown into, smoky vapor will pour from the open-mouthed bottle.

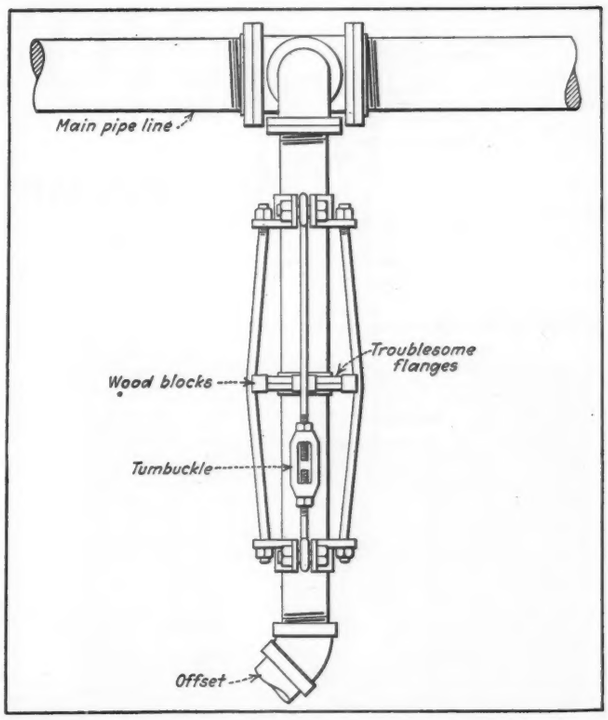
Another material that will produce a dense vapor for this purpose is titanium tetrachloride, a chemical used in the War by the Air Corps for laying down smoke screens. It vaporizes promptly on exposure to the air. This material has been adopted by some of the drying kiln manufacturers for the purpose of studying air currents in kilns. One simply removes the stopper from the bottle, and a dense white vapor comes forth.

Stiffening Device Stops Steam Line Leakage

J. A. Denny, St. Louis, Mo.

From the main pipe line through which steam was supplied for process work a smaller pipe dropped vertically to connect with a pipe line running horizontally through a tunnel to an adjoining building. The vertical pipe was offset near its lower end with several 45-deg. elbows, above which point this pipe consisted of two lengths joined by a flanged union. Vibration set up by the irregular flow of steam through the line was the cause of much trouble with this union. Although the gasket joint between the flanges held tight the threaded connections between the flanges and the pipe lengths persisted in jarring loose and leaking. Consequently the flanges had to be replaced about every two months.

The maintenance man on the job finally hit upon a



scheme for stiffening this part of the line and so mitigating the vibratory effect. The device used is shown in the accompanying sketch. At distances of about 3 ft. above and below the troublesome union clamps made of heavy bar iron were attached. The clamps were joined by four tierods extending over blocks of hard wood set against the edges of the flanges. Two of the rods were fitted with turnbuckles for drawing them taut, whereas the other two were pulled up by means of adjusting the nuts on their ends. The bridle thus formed held the union and pipe ends rigid, so that localization of the jarring in the threaded joints was avoided.

By-Pass Feeder Connections

R. H. Parrish, Mission, Tex.

Some type of compound, chemical fluid, or process material often is introduced into the medium of hot water supply systems, hot water heating systems, and steam heating systems to minimize the formation of scale. The by-pass type of feeder is the one almost universally used for this purpose. Unfortunately there are many incorrect ways to connect such a feeder into the system, whereas, in each case, there is only one correct way.

Perhaps the by-pass feeder is used most extensively in hot water supply systems. The reason for using this type of feeder is because it feeds the fluid into the system gradually, so that every gallon of water passing through the system is mixed with a uniform amount of the fluid. The correct way to install the by-pass feeder in a hot water supply system is shown in Fig. 1. The feeder is attached with a second, or equalizing connection, which runs from the outgoing hot water line to the top of the feeder, to assure a uniform flow. The necessary valves are indicted. After the valve *D* has been

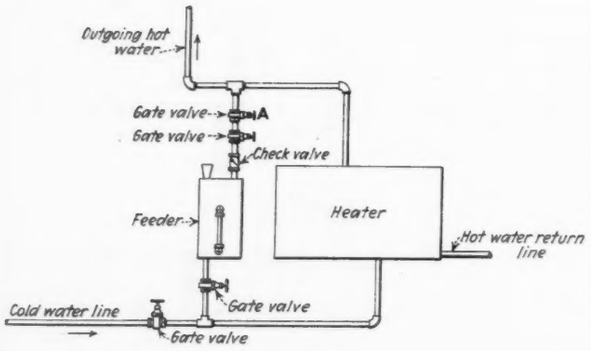


Figure 1

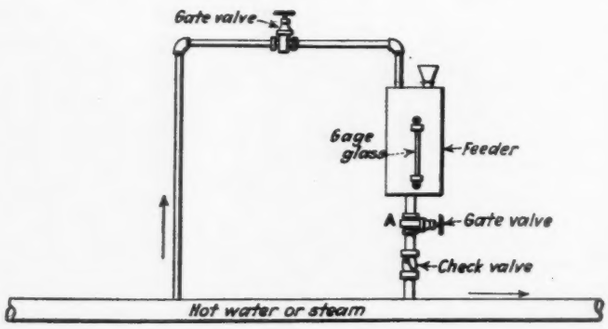


Figure 2

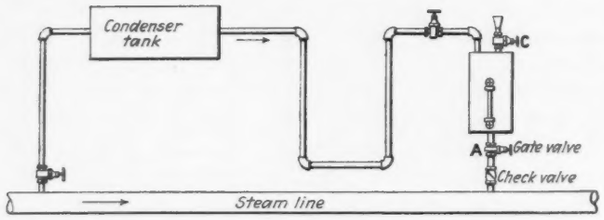


Figure 3

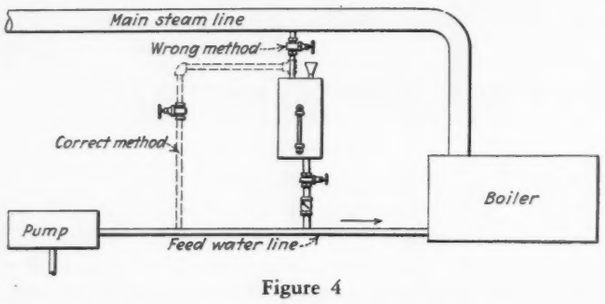


Figure 4

adjusted to give the desired flow, it is left alone. All other valves are operated each time the feeder is filled.

The by-pass feeder also is used with hot water heating and low pressure steam heating systems. The correct way to install the feeder for these systems is shown in Fig. 2. The feeder is connected into the return hot water or steam line just before it reaches the heater or boiler by means of an equalizing connection to the same line but just ahead of the main connection. Once valve *A* is adjusted for the desired flow it is left alone, whereas the other gate valve is operated each time the feeder is filled.

Finally we find the by-pass feeder used with high pressure steam lines. The correct way to install the feeder for this class of system is shown in Fig. 3. It is attached to the main steam line just after it leaves the boiler and before branching. The feeder always should be installed in a horizontal section of the line. The hook-up differs from the preceding ones in that a condenser tank is required. After valve *D* is adjusted for the proper flow it is left in that position, whereas the others are operated each time the feeder is filled. As in all the other systems the check valve serves to keep the fluid from backing up through the feeder.

Fig. 4 shows a common fault in connecting a feeder. This mistake is the result of many engineers thinking that the main steam line carries the highest pressure around the plant. The correct connection is shown by the dotted line. When connected correctly the feeder will cause the fluid to flow from a drop at a time to a stream.

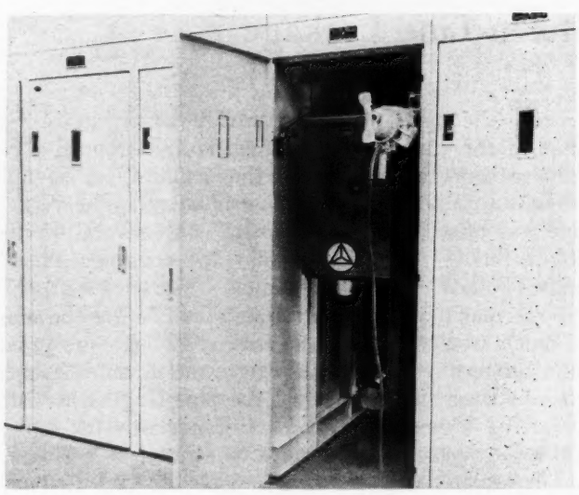
More Wood Will Be Used

Rings, plates, and disks of metal used as connectors to strengthen joints between timbers have been developed to the point where they increase the strength of timber structures from four to eight times, according to a report soon to be published by the National Committee on Wood Utilization and the Forest Products Laboratory of the U. S. Department of Agriculture. The increased strength permits either a decrease in the gross sectional area of the members, or the use of lower grades of the same or weaker species—with consequent decreases in the cost of materials. New types of wood structures hitherto not attempted in this country, are now being erected.

The Electric Drill Finds a New Job

SOURCE, Delta-Star Electric Company, Chicago, Ill.

Lowering the oil circuit breakers of metal-clad, ventilated switchgear by hand with the aid of a handwheel or or crank, requires muscle and takes time. Electric hand drills are now being used to do this work. It's easier on the men and speeds up the job.



MOTION STUDY. . .

. . . trying it on the dog

Invest a little. Save much. That's what happens when foremen and workers learn to look at their jobs in the light of motion economy. Here's how better dog collars are being made at lower cost!

Walter P. Cahill

Works Manager
Graton & Knight Company
Worcester, Mass.

When packing dog collars by the former method, the girl opened a cardboard box on the bench and collected twelve collars to make up the desired assortment. After closing the box, it was placed in the truck at the right. Eleven steps were taken for each box packed. . . . Now the girl works at a circular bin, so that with simple and symmetrical motions she can pick up three collars in each hand, working toward the center. The six collars are dropped into the pivoted chute at the center, and the operation is repeated on another level. The chute is tilted, allowing the twelve collars to slide into a manila envelope, which has replaced the bulky box at one-third the cost. Immediately below the chute is mounted a stapler, and the fastened envelope drops into the container below. While the girl is working on one side of the bin, another is filling the compartments in the other half. No walking at all, much less fatigue, and a reduction in labor of almost 60 per cent. The rack paid for itself during the second week of operation.

SOMEHOW, as we watched the results which others were getting from motion study, it seemed as if most of the applications had been made in larger plants—those with mass production, something we do not have. A very brief experience has taught us that this impression was wrong, and that much could be accomplished by presenting the fundamentals of motion study in such a way as to lead everyone in our organization to apply these principles to his own job.

Our first move toward this end was to set up a training program for supervisors, starting with a series of discussions, in order to get everyone to thinking in terms of motion economy.

Motion study, we found, is a combination of two main objectives—analysis of the work to be done in order to determine the best possible manner of doing it, and an accurate determination of the time required.

Time studies alone can be performed by a specially trained force with satisfactory results. Motion study, however, is not the function of a single department; it is the concern of every superintendent, foreman, and worker. It is a function of supervision and should be a necessary part of supervisory training and experience in order to accomplish the greatest good. The foreman who has learned the value of motion economy can often by observation alone correct the improper and unnecessary motions in his operations, while the time-study man trained in motion study can be of valuable assistance to the foreman in suggesting better methods. Through his experience he can also develop fundamentals in one department that will be applicable in others.

Thus the foreman, by analyzing motions, and the time-study man, through his all-round experience, can perfect the method to be adopted. Further help may be had through suggestions from the workers themselves. A good suggestion system will often bring out valuable ideas. Above all, we have found it essential to have the cooperation of every man in the plant; with it great improvements can be made in factory processes and oper-

Three Jobs in One!

1 This is the new method by which three operations are done at one and the same time. The girl places the strap in the fixture, and at a single stroke a multiple die punches the holes, points the end, and stamps the collar size. Formerly the machine was used to punch holes only. The foreman is now working out a plan which has this one beaten. But let's see how the other operations were performed.

2 Pointing was done with a cutting die similar to the one which rounds the other end of the strap. One hand held the strap. The other fed the press. Straps are now pointed as in 1, combining three operations.

3 Rounding the end as shown in 2 is now accomplished in the following manner. Two straps are grasped, one with each hand, and butted together. Two dies were welded back to back, and the double die now does two at a time. The finished straps now drop into the trough. No putting away. A saving of 35 to 40 per cent has already been secured. Don't write in and tell us the operation is dangerous, because the guard was removed in order to get a better picture.

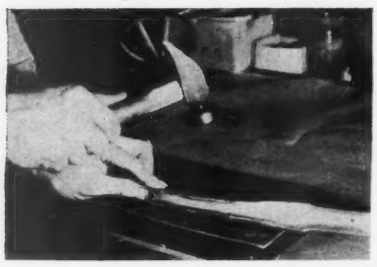
ations. Immediately after establishing this training program, results began to appear. We were literally trying motion study "on the dog," for the first applications were made in the manufacture of a complete line of dog collars and harness. A good-natured spirit of rivalry developed between two of the foremen, and each strove to outdo the other in the applications he was able to make in his own department. To illustrate, we have selected several of the operations that were studied, and both in the text that follows and in the accompanying photographs, "before" and "after" methods are shown.

Savings in floor space, reductions in the amount of work in process and of raw materials on hand, improved quality—all these are of paramount importance and in many instances were the direct results of our program. Each step in the manufacture of the product was submitted to searching questions. Why? what? how? who? when? and where? Now when we look back on some of the changes, we wonder why we never thought of them before.

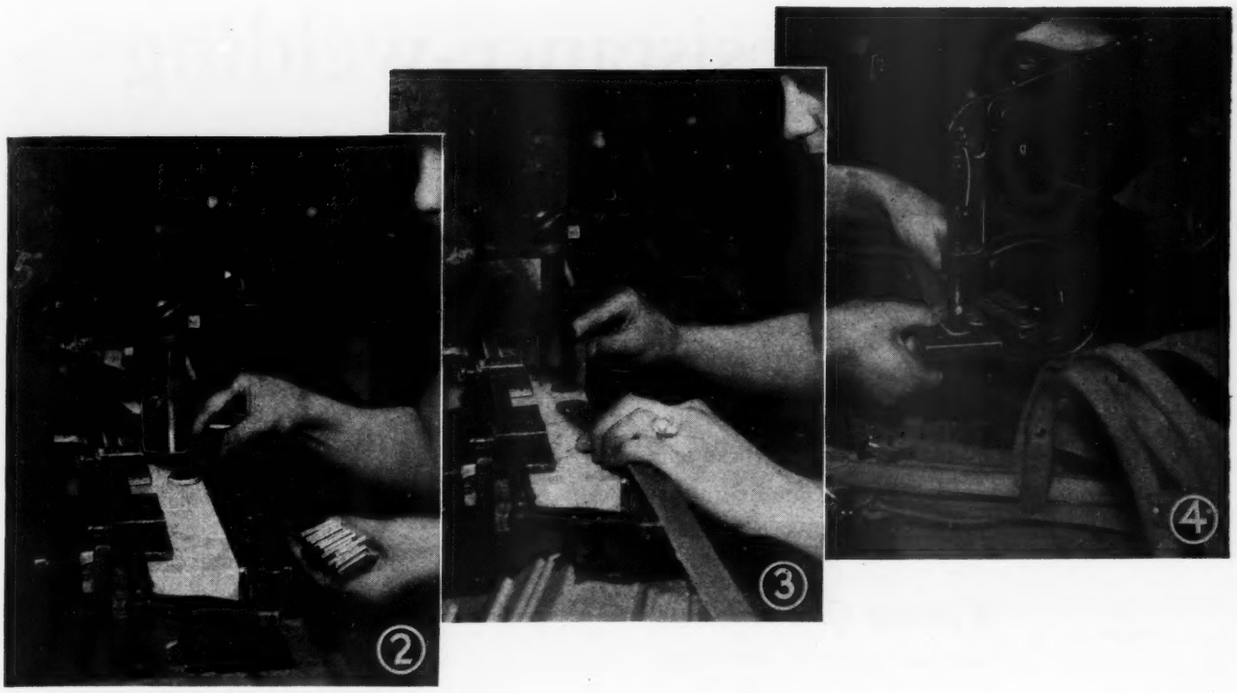
For example, a new method of attaching the buckles and dees to the collars was worked out. It meant at least an 18 per cent saving. It was also possible to train new girls on this operation in five to ten hours, whereas formerly it took from ten days to two weeks. Locating felt bins at the stitching machines saved approximately one hour a day. Felt was formerly carried back and forth from the stockroom. Stitchers had to wait while someone in authority went to get it. A total saving of $150 yearly at a cost of $10 for the bins!

Other applications—for example, the assembling and packing of collars—are described in the captions that go with the photographs. The same reasoning then obtained in the collar assembly was applied to putting up dog harnesses and leads. The operation was taken from a long table and, instead of being inspected and put away in bins, taken out again, and packed in boxes, which were sealed and stamped at another bench, the method now is to inspect the harness and place it within arm's reach in the new rack. It is assembled without leaving the central position. then packed in boxes, which can be sealed and stamped all at the same location. The saving here amounted to almost 50 per cent, and enabled us greatly to reduce the floor space required.

These were simple applications, yet the resulting economies have reduced the cost of some of the products in this line so that we have been able to accept several large orders which could not otherwise have been secured.



In making the rounded collars, it was necessary to perform the operation illustrated here. Hand hammering. Slow, awkward, and fatiguing. But the main difficulty here was with quality. A great many of the collars came out of the operation cracked, which meant a good deal of time spent in reworking—an expensive and unsatisfactory procedure whatever may be the product you are making in your plant.



4 After pointing and punching the holes, the straps were then taken over to this small stamp where the size was suitably impressed, as illustrated here. By mounting these small numbers on studs, it is a simple matter to make changes on the combined die used in 1. One trip of a press now does all three operations, saves handling, trucking, floor space, and inventory. Just common sense. Yes, but it will return approximately ten times the investment in new equipment.

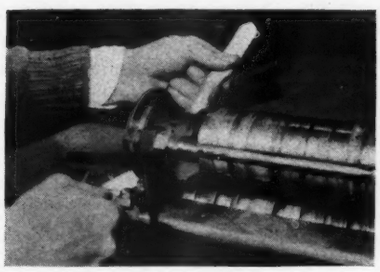
What we have done, is but the beginning. Everywhere in our organization operations are being submitted to a searching scrutiny. Why do we do it this way? Is there a better way? And so on. No longer does each foreman regard his job as done when the product leaves his department. He is interested in the form in which it is delivered to the next man. Often it is possible to reduce costs by combining operations which, in the past, were set up by departments. Interest and enthusiasm in motion economy soon spread, and today the plant as a whole feels that its objective is to make a better product at a lower cost—to the profit of all concerned.

The reaction of the supervisory force to this educational program is reflected in the following interesting statement—it was made by one of the foremen in his first report on some of the changes which have been so briefly described in this article. He said:

"The chief value of motion study for me is that it brings understanding of the value of the different movements as to length and position, also the time elements entering into inspection or focusing of the eyes. The use of both hands on one item is easily overlooked, and systematic procedure of motion study is of great value in training new help."

Our program of education in the principles of motion economy will continue. Discussion of case studies will serve to emphasize fundamentals. Questions regarding the design of machines and tools will be discussed. Safety as an integral part of every operation will be considered. We shall have hundreds of minds, instead of just a few, directed toward the problem of eliminating waste from our manufacturing operations.

Today we feel that we are well on the way toward making the better product at lower cost which is what every manufacturer is after, and we are sure that the application of motion economy common sense has been—and will continue to be—one of the really vital factors in the attainment of that objective. The savings cannot always be figured in dollars and cents, but we know that without the production economies resulting from early steps in our program of education in "motion-mindedness" we could never have accepted with profit a substantial number of large orders which we have recently been able to secure.



Why do we do it that way? As a result of asking ourselves this question, the strap is now placed under this power-driven roller, the foot pedal is depressed, and out comes a perfectly rounded collar in a few passes. These are but samples of the many excellent suggestions received from the men in the shop. They illustrate the motion-minded man's approach to the problem of getting better products at lower costs.

Balancing resistance-welding machine loads on shop lines

▸▸ **Low-cost production and other advantages offered by resistance welding may be lessened by the undesirable characteristics of the electrical load imposed on the power lines. The production department should know what these characteristics mean and what they cost. The maintenance department must know how to overcome them.**

Warren C. Hutchins

Industrial Engineering Department
General Electric Company
Schenectady, N. Y.

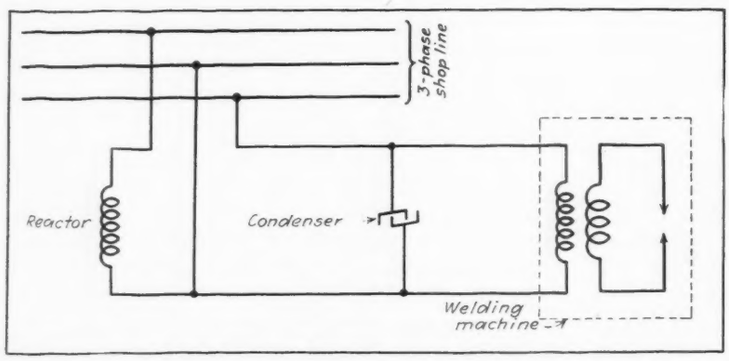


Figure 1—A combination of reactors and condensers can be used to balance a single-phase load on a three-phase line, but the power factor of the load will remain the same.

ADVANCEMENTS in manufacturing processes have included speedier and more powerful resistance-welding machines. The large values of single-phase current at low power factor required by this process, and the fact that the demand fluctuates from a maximum to zero at short intervals, presents a serious problem in power supply.

To supply this single-phase service directly is expensive both to the industrial plant and to the central station; therefore, in view of economies that can probably be realized it will pay to provide means of improving the characteristics of resistance-welding loads.

Resistance welding can be divided into several classes, such as: (1) Spot or projection welding; (2) Slow butt welding; (3) Flash welding; (4) Line welding (sheet metal).

Commercially accepted values of the power required and the time of application for spot and projection welding are given in Table I for various thicknesses of sheet metal. The power factor usually ranges between 25 and 40 per cent.

Actually the values in Table I have been exceeded because the advent of Thyratron-tube control has permitted a great increase in the speed of welding through very accurate timing of the duration of power application.

In Table II are given commercially accepted values of power and time required for slow butt-welding round stock. Power factor for slow butt-welding machines is usually 40 to 70 per cent. The time power is off is usually equal to, or greater than, the time of application.

The power and time required for flash-welding heavy plate or beams are approximately as Table III shows. Power requirements for flash welding will vary with the shape of the area to be welded. The time power is off is usually several times as long as the sum of the flashing and the upset periods.

Inherent characteristics of the line-welding process for sheet metal make it necessary to interrupt the welding circuit rapidly as the work moves along. The result is a series of overlapping spot welds, producing one continuous seam. The capacity of line-welding machines usually ranges between 50 and 300 kva.,* depending upon the thickness of the work and the speed of welding.

Usually line welders are equipped with mechanical contactors that interrupt the welding circuit 100 to 300 times a minute, but with Thyratron control interrupting speeds up to 1,800 times a minute are practicable. Now intermittent line welders that draw from 300 to 700 kva., on and off every few cycles, are in operation.

For the power generation viewpoint, resistance-welding loads have these inherent characteristics:

1. Single-phase power; causes unbalancing of a polyphase system.

*The term kilovolt-amperes (kva.) refers to the product of volts times amperes times 1,000, and is the measure of the *apparent* power in an electrical circuit, not all of which may be available for doing useful work. Kilowatts (kw.) indicates the measure of power available for doing useful work. One kilowatt represents about 1⅓ horsepower. Power factor is the ratio of actual power, true watts, to apparent power, and thus may be considered as the measure of the efficiency with which electrical energy is used. It follows that kva. times power factor equals kw. Thus a machine drawing 100 kva. at 50 per cent power factor represents a load of 50 kw. In other words, only 50 per cent of the power drawn from the line is doing *useful* work.

2. Very low power factor, usually below 50 per cent.
3. Intermittent, quickly changing load.
4. Extremely high peak-power demands.
5. Total energy consumption is low.

Experience has taught utility companies the necessity of considering power factor when billing consumers. Probably the most widely used method of charging for low power factor is to establish a billing factor, which when multiplied by the base power rate will determine the billing a kilowatt-hour to the consumer.

For example: Billing factor = Base power factor of rate ÷ Consumer's power factor.

The rate base power factor is usually 80 per cent.

As an example, consider a plant where flash-welding equipment is used to weld stock of 5-sq.in. cross-section (see Table III). Assume that base rate is 1.5 cents a kilowatt-hour, base power factor of rate is 80 per cent.

It is found that the peak power demand for one welder is 810 kva. at 40 per cent power factor, or 324 kw. Then, billing factor is $80 \div 40 = 2$.

Therefore, the power cost a kilowatt-hour would be the product of 1.5 cents times the billing factor of 2; or 3 cents for all power consumed. In other words, the plant will pay for power just double what it would pay if the power factor were 80 per cent or higher.

Another factor which often increases the cost of power is that existing power lines may not be large enough to carry the welding load, so that there are voltage fluctuations and flickering of lights throughout the factory. To improve this condition, it is necessary either to run a separate power circuit to supply the welding load from a high-capacity transmission line, or to improve the characteristics of the welding load. If the power line were installed the plant probably would have to pay 10 per cent of the cost of the line annually for interest and maintenance.

Several different schemes have been used to improve resistance-welding load characteristics, such as:

1. Attempts to balance the single-phase load on a polyphase system, by ingenious transformer connections.
2. Use of reactors and capacitors to accomplish the same purpose.
3. Use of a motor-generator set to balance the load, improve power factor, and, by spreading the load over a longer time, reduce the peak demand.

The first method of balancing a single-phase load on a polyphase line is not practical.

Where the single-phase load is constant and it is desired to balance it on a three-phase line, the arrangement suggested under Method 2 can be used for some installations. Figure 1 shows the arrangement schematically.

Assume a single-phase load of 200 kva. at 40 per cent power factor, always the same value, but coming on intermittently. With the scheme shown in Figure 1, the load reflected on the three-phase system will be balanced, but the power factor of the load will be unchanged. Consequently a little more than 200 kva. at 40 per cent power factor (including reactor and wiring losses) would be drawn from the line.

Use of a motor-generator set, Method 3, makes the welding load a desirable one for the power companies, and often less expensive for the industrial plant. As shown in Figure 2, a suitable three-phase motor is used to drive a single-phase generator which furnishes the power for welding.

When the duration of the welding load does not exceed two seconds or slightly more, it is usually best to use a high-slip induction motor driving a generator equipped with a flywheel. These advantages are gained:

1. The load is balanced on the polyphase system.
2. Power factor of the peak demand will be improved to about 90 per cent, becoming less under partial load and during idling period.
3. Demand for power will be spread over a longer period, decreasing the peak demand. The flywheel stores energy during no-load period and gives it up during load period.
4. Independent control of the voltage permits greater flexibility of operation of the equipment.

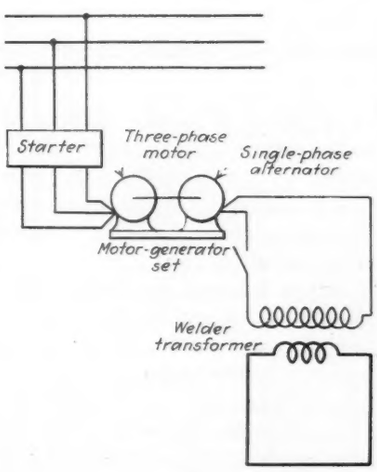


Figure 2 — A motor-generator set consisting of a three-phase motor driving a single-phase generator constitutes one of the most desirable means of furnishing power to a resistance-welding machine.

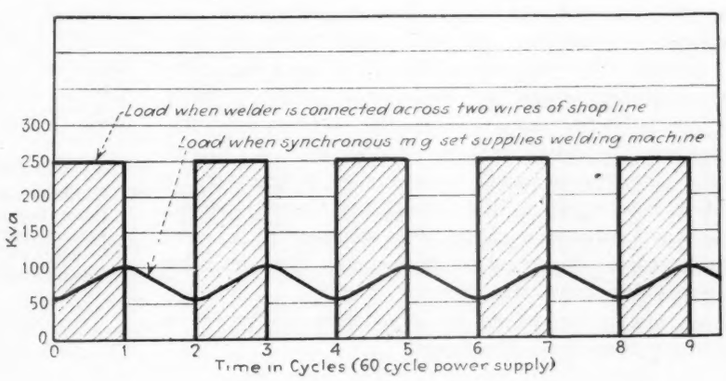


Figure 3 — Load reflected on power supply by a typical line welder connected to it in two different ways. When the welder is connected across two wires of the shop line, a heavy load of approximately 50 per cent power factor is imposed. A synchronous motor-generator set supplying the welding load imposes on the shop line a balanced polyphase load at 100 per cent power factor.

TABLE I—SPOT WELDING

Gage of Material U. S. Standard	Kva. at 33% p.f.	Time power is applied, seconds	Projection Welding Kva. at 33% p.f.	Projection Welding Time power is applied, seconds
28	15.1	0.3	40.3	0.10
24	21.2	0.5	63.6	0.11
20	27.2	0.7	81.6	0.15
16	36.4	0.9	110.0	0.20
12	48.5	1.3	140.0	0.28
8	60.6	1.7	180.0	0.32
6	66.7	1.9	200.0	0.40

TABLE II—SLOW BUTT WELDING

Diam round stock, In.	Kw. Required	Kva. at 60% p.f.	Time, Seconds
0.5	5	8.4	5
1.0	18	30.0	20
1.5	50	83.3	40
2.0	75	125.0	50
3.0	120	200.0	55

TABLE III—FLASH WELDING

Area of section, Sq.In.	Flashing Period: Kva. at 60 to 70% p.f.	Flashing Period: Time power is applied, seconds	Upset period, Duration 1 to 2 sec. Kva. at 40% p.f.
1	60	4	180
2	120	4	360
3	180	5	540
4	230	5	660
5	270	5	810
10	530	6	1,600
20	1,000	7	3,000

The duration of power application to a slow butt welder is usually 10 to 40 seconds or more. Usually a flywheel is not applicable to this type of load, because it would be necessary to use an exceedingly large wheel. A synchronous motor, however, is suitable and offers the following advantages:

1. Load is balanced on three-phase line.
2. Power factor can be made unity or leading.
3. Total kva. demand will be reduced because of improvement in power factor.

An induction motor would offer the same advantages, with the exception of power-factor control.

In flash welding the parts are clamped in the jaws of the machine, touched together, and then drawn apart a few thousandths of an inch. Current flow established when the parts are touched, is kept up when they are separated, producing an arc that is maintained for several seconds. The gap between the parts has a high electrical resistance; therefore, the power factor is fairly high (60 to 70 per cent). When the surfaces are sufficiently hot, the parts are forced together or "upset" under high pressure; while upsetting, it is necessary to maintain flow equal to that during the flashing period, and a heavy surge of current flows at about 40 per cent power factor until the circuit is opened. It is desirable to prevent this surge of current.

If an alternator driven by a synchronous motor is used, these advantages are gained:

1. The load is balanced on the polyphase line.
2. Synchronous motor permits adjustment of power factor.
3. Peak power demand will be reduced.
4. Decrease in the welding current to be interrupted by the contactor at the completion of the weld.

Probably the last two advantages warrant explanation.

Assume that parts having 5 sq.in. cross-section are being flash welded. From Table III the power required is 270 kva. at 65 per cent power factor, or 175 kw. A generator suitable for this machine would be rated 270 kva., and assuming generator efficiency of 89 per cent, a 265-hp. motor would furnish ample power.

The load reflected on the power source during the flashing period would probably be 212 kva. at unity power factor, including all losses.

During the upset period the alternator voltage would be allowed to droop thereby reducing the power surge. The generator could be designed to have the voltage drop approximately 60 per cent. Then instead of 810 kva. at 40 per cent power factor during upset, there would be no more than 320 kva. at 40 per cent power factor, or 128 kw. Including all losses, the load reflected on the shop line probably would not exceed 163 kva., representing a reduction of nearly 80 per cent.

Recently an Eastern manufacturer desired to install a seam welder for making high-speed welds on metal containers. It required 250 kva., single-phase, at 50 per cent power factor, on for two cycles, and off for two cycles. The power company refused to allow this load to be connected on two wires of the incoming three-phase shop line, because troublesome flickering of lights would have been inevitable and the unbalancing of the system would have created other serious problems.

Erection of a single-phase line to carry this load would have cost more than $15,000 (including the necessary transformers).

Study showed that a synchronous-motor-driven, single-phase alternator would transform the pulsating, low-power-factor welding load of 250 kva. into a continuous, balanced load at unity power factor and reduce the peak demand enough to permit connection to the existing shop lines. Comparing the two conditions:

Welding Load	*Motor Load on Shop Line*
Single phase	Balanced three phase
Power factor 50 per cent	Power factor unity
Intermittent load, two cycles "on," two "off".	Load continuous
Intermittent load, 250 k.v.a.	Continuous load, 80 kva.

This equipment is now in operation and the plant pays the base rate for power because the welding power requirements are at unity power factor.

QUESTIONS and ANSWERS

Conducted by G. A. VAN BRUNT

Short-Center Drive on Pulsating Load

Is it advisable to use short-center belt drives on machines whose loads pulsate violently? We have several machines somewhat like bolt headers. A very heavy peak occurs once each revolution of the drive pulley. The machines are driven by 10-hp., 1,200-r.p.m. motors with 7-in. pulleys; the driven pulley is 48 in. in diameter, center distance about 14 ft. Some trouble has always been experienced from flapping of the belts, but it has not been serious. It is now proposed to save floor space by cutting the center distance to about 6 ft. but I fear that this will increase the strain on the belts and lead to shorter life because the same shock will have to be absorbed by a shorter length of belt. What do readers think? J. B.

Birmingham, Ala.

IT IS not possible to state definitely that a short-center drive is practicable in this instance, because the description "heavy peak load once each revolution" is not sufficiently informative.

I can say that many violently fluctuating loads apparently similar to the one described by J. B. are now being driven on short centers. These short-center fluctuating drives are all equipped with either a gravity idler or a pivoted motor base to maintain the proper effective tension.

The belt used on a short-center drive should be of special tannage with high coefficient of friction and flexibility. This is particularly necessary where a balanced idler pulley is used, since the double bend in the belt soon deteriorates ordinary oak tannages.

With such an installation 6-ft. centers would be a considerable improvement, and should eliminate entirely the flapping of the belt. A special device such as suggested is necessary for satisfactory operation.

ERNEST L. BALDWIN
President
Baldwin Belting & Leather Company, Inc.
New York, N. Y.

MUCH depends upon the severity of the pulsations. The statement that the loads "pulsate violently" is sufficient to make one cautious in offering recommendations.

For fixed-center drives if the center distances are short and, or, the belt speed is high trouble may be encountered. Both conditions can be met satisfactorily, however, if the motor is placed on a pivoted mounting to keep the belt uniformly tight. Many belts driving fluctuating loads have been shortened successfully in this way, and the belt receives less punishment than on fixed-center drives.

With long belts the amount of stretch in the tight side at each pulsation is considerable. The lengthened belt then permits slackening on the pulleys and slippage occurs, which is hard on the belt and reduces the speed of the driven machine. Although it is true that the same shock will have to be absorbed in the shorter belt, the free movement of the motor on its pivoted mounting tends to cushion the shock, and experience shows that the belts stand up much longer.

When shortening drives and applying the pivoted base one must be careful to see that the load fluctuations do not cause synchronized oscillations of the motor on the pivot (at least not enough to throw oil or affect lubrication). If the impulses set up too great a movement of the motor it may be desirable to use a simple snubber or shock control at the outer end of the motor mounting, similar to devices used on automobiles.

W. D. HAMERSTADT
General Manager
The Rockwood Manufacturing Company
Indianapolis, Ind.

TWO FACTORS enter into the operation of a belt on any pulsating drive: (1) The constant, sudden jerks tend to stretch the belt much more than would be the case if the load were uniform. (2) There is likelihood that the belt will slip slightly on each pulsation, thereby wasting power and shortening the life.

The old theory was that on pulsating loads the belt should be as long as possible in order to provide a long section between pulleys to take up the sudden shock without producing permanent stretch. All belting materials have a certain amount of elasticity which permits them to stretch and recoil slightly under sudden overloads. However, some belting materials possess much greater elasticity than others; therefore, a short-center drive equipped with a very resilient type of belting can be much more satisfactory than a long-center drive equipped with a belt that has little elasticity.

The tendency of a belt to slip under a sudden load is more easily overcome by using a belting material with high friction value than by using a long belt. A belt that has great gripping power will transmit power more efficiently on a reasonably short center drive than ordinary belting might do on a long-center drive.

Flapping of the belt is more likely to occur on a long-center than on a short-center drive. A slight pulsation in the load, repeated regularly and frequently, is likely to set up flapping in a long belt. Unless the sudden overloads are very severe flapping probably will disappear on a short-center drive.

Use of a heavy driven pulley is one of the best ways to smooth out a fluctuating load. The question states that the driven pulley is 48 in. in diameter. It should have some flywheel effect, but if it is insufficient a heavier pulley might be used.

I have seen many fluctuating drives converted into short-center drives by the use of motor bases which use the weight of the motor to apply tension to the belt. With a fixed mounting of the motor on a fluctuating drive the belt is in a stretched condition immediately after an over-

load occurs, and before it can recoil it will permit a certain amount of slippage on the pulleys. This action is entirely overcome by these special motor bases, which permit the motor to "float."

They are ideally suited to shock loads because the shock is taken up by the weight of the motor. On a short-center drive with fixed motor mounting the shock is transmitted to the bearings of the machine and motor. On a long-center drive it is partly taken up by the elasticity of the belt. With the floating motor mounting both belt and bearings will last longer because the weight of the motor is used to absorb the shock.

From the conditions set forth in the question I believe that a 4-in. double flat leather belt of high frictional qualities would handle this drive very well on 60-in. centers.

V. W. WELLS
Engineering Department
E. F. Houghton & Company
Philadelphia, Pa.

SHORTENING this drive is not desirable, in my opinion. The belt would have to be kept very tight in order to prevent slippage and that would shorten its life. I would recommend changing this to a V-belt drive. The wedging action of such belts provides the necessary friction to prevent slippage and give long life.

The correct drive can be selected from the belt manufacturers' catalogues. With one exception, install from one and one-half to two times as many belts on the drive as recommended. A method of tightening the belts is desirable, especially on pulsating loads.

We have put V-belts on all of our troublesome drives and practically forgotten them.

J. C. WATSON
Lansdale, Pa.

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How to Make Lubrication Survey

It has been suggested that ways of saving money might be revealed by a thorough study of our lubrication problems and requirements. Ours is a metal-working plant, handling small and medium-sized parts. About half of our equipment is driven from lineshafts; the remainder is driven by separate motors. Some equipment, including part of the motors, has ball bearings, but plain bearings are used mostly. From their experience can readers tell me how to make such a study? What information should be collected? O.M.E.
Detroit, Mich.

MANY bearing failures and excessive oil consumption were playing such an important rôle in causing high operating costs that a survey was made in which I took an active part.

First, a well-known lubricating engineer representing a reliable oil company was called in and the quantity of oils and greases used during the past year was summed up in gallons and in dollars. The result was beyond reason.

The next step was to determine how many different grades were used, and where, or whether just any oil was poured into a bearing because "oil is oil" and can be taken from any drum that holds some and is equipped with a faucet. Bearings in which the most oil was used were considered first.

A few instances were found where the improper grade of oil was being used. Some bearings were not receiving the oil poured around and over them. The long-spouted oil can was found to be a source of waste, along with operators' carelessness.

Lineshaft bearings of the ring and collar type were sealed to keep out dust and moisture. Wipers and end seals were put in order. Bottle oilers were installed. They have served well and require very little attention other than removal from time to time to make sure that oil is flowing down the wire.

Open-top bearings that previously were lubricated by means of the oil can were sealed tight and wick-feed oilers were installed. The amount of oil required is determined by the shaft speed and is regulated by the amount of wick used. On such installations bearing failures almost have been eliminated.

Motor bearings had given a great deal of trouble, which was cleared up by selecting bearing alloys that would give the best service under the operating conditions. The grade and quality of lubricant adopted also played an important part in eliminating trouble.

For example, bearings using forced-feed lubrication were giving trouble. If the grease used were not given attention frequently it would clog and cause bearing failure. Heavy oil was substituted here with good results.

Compressors and reciprocating machines on which we used adjustable sight feed lubricators were found to be using an excess of oil. An oil pump was installed and the flow regulated so that each bearing receives the proper amount of oil. Compressor valves soon told the story, since very little carbon was found. The saving in oil was remarkable.

Proper lubrication requires studies that can not be finished in a short time. Lubricants should be obtained from reliable oil companies, to insure uniform quality. It is well to avoid using too many grades of oil. One grade may serve in several places if study is made of the requirements and the best methods of meeting them.

Dunbar, Pa. L. D. BRYSON

●

Procedure in Babbitting Bearings

When rebabbittng motor sleeve bearings what precautions should be taken in order to obtain the best results? Information on putting bearing shells in proper condition, pouring temperature of the metal, and other points that should be watched, will be appreciated. G.F.M.
Covington, Va.

WHEN rebabbitting sleeve bearings be sure to use a shell that will stand the change in heat and not warp. Do not try to rebabbitt a white metal bearing.

First bore out the shell about 30 per cent; that is about enough on any size of bearing. Then drill three or four holes in the side of the shell to serve as an anchor for the babbitt. When heating the babbitt always stir the metal with a small pine stick. When the stick chars the metal is ready to pour.

Wrap the bearing with asbestos or paper and set it in sand or clay so the metal will not run out. Apply heat to the shell before pouring so that the babbitt will not be chilled too fast.

In cutting the grooves for oil distribution cut one on each end and connect the two with a parallel groove on each side that catches the bottom of the slot for the oil ring. Drill a hole in the bottom of each end groove to serve as a drain. E. W. REICHL

Chief Machinist
Arc Electric and Elevator Co., Inc.
St. Louis, Mo.

●

Repair in the Shop, or Send Out?

The advisability of doing our own motor repair work has been questioned. Our motors are mostly squirrel-cage type, with a few wound rotors and some d.c. machines that drive elevators and certain production machines. Will some one tell me, in general, (1) how many motors of the above types a plant must have in order to justify doing its own rewinding? (2) On what basis should one determine whether to make motor coils, or buy them from the motor manufacturer? (3) What is the practice of other industrial plants in regard to the amount of spare parts and repair materials carried in stock? How should requirements be figured? R.O.K.
St. Louis, Mo.

THIS question would be easier to answer if the number of burn-outs a year were given. If there is enough work to keep a winder employed steadily a plant can save money by doing repair work in its own shop: (1) In freight or hauling to a commercial or manufacturer's service shop. (2) In the overhead and profit that are included in the commercial shop's charges. (3) In time, since emergency repairs often can be made without removing a motor from its drive. (4) In maintenance, because when rewinding is done in the plant's own shop the cause of motor failures will be discovered.

If there is not enough work to keep a man busy on rewinding jobs, it has been found in many shops that it is economical to keep a man who will do routine inspection and testing along with the winding.

As a rule it does not pay to make coils in the shop because considerable expensive equipment is required and it is necessary to carry a large stock of wire and insulating material in order to do rush jobs. Coils usually can be obtained quickly from the manufacturer, or can be made up at a very fair price by a commercial shop that has coil-making equipment.

Manufacturing conditions vary widely in industry and these conditions govern the amount of spare parts and materials that should be stocked. In order to maintain production spares must be available, but when the investment in stock parts is too heavy the profits of production go to carrying charges on the spares.

The aim should be to have sufficient spares to keep production going in spite of any but the most unusual breakdowns. From the maintenance engineer's viewpoint the best policy is to have an excess of spares at the expense of overhead, because when production stops on account of a breakdown reasons or excuses do not go over very well. If no failures occur it speaks well for the maintenance man, and the overhead in spares should be justified on the basis of production insurance.

Chief Electrician
Bessemer Limestone & Cement Co.
Youngstown, Ohio
J. E. MCILVENNY

ANSWERS WANTED

Relation of Maintenance Costs to Plant Activity

I am not satisfied with the budgets of our maintenance department; they appear to bear little relation to our rate of production, which varies considerably. Have any readers prepared monthly or other short-term maintenance budgets that are based on the total payroll, volume of production in dollars or percent, or in some other way related closely to the activity of the plant? If so, I should like to have the details, including the percentage relations that have been established. Of course, such relations will vary with different industries, but I should like to know what they are in a general way. P.V.

New York, N. Y.

What Rating For This Generator?

How large a generator will be required to supply power to a group of 60-cycle, three-phase, 220-volt motors ranging from 1 to 25 hp., with a total rating of 110 hp.? At times all of the motors will be running at practically full load. The generator will be direct-connected to a steam engine which has a governor in the flywheel and four mechanically operated valves. Since the load on the generator will vary considerably will it be necessary to use a voltage regulator? H.P.

Grand Rapids, Mich.

Will Radiators Operate Below Boiler Level?

Is it possible to operate successfully one or more steam radiators placed anywhere up to 10 ft. below the level of the boiler? This is not a vacuum system and we do not want to install pumps to return the condensate to the boiler. C.H.

Baltimore, Md.

V-Belts on Flat Pulleys

Will the life of ordinary V-belts be shortened seriously by running them over flat pulleys? We are installing several V-belt drives on which it will be necessary to change the speed occasionally. Since we have a number of flat steel pulleys on hand we do not want to purchase different sizes of grooved pulleys if the flat ones can be used on the driven machines. The motor pulleys will, of course, be the regular grooved type used with V-belts. B.H.

Milwaukee, Wis.

·EQUIPMENT NEWS·

Insulation Resistance Tester

Called the "Midget" and is an addition to the line of Megger insulation testing sets. Features of this instrument are its small size and weight; over-all dimensions are 5¾x4x2⅜ in.; weight is 3 pounds.

Consists of a direct-reading ohmmeter, combined with a special 500-volt

d.c. hand generator; no outside source of current is required. Spring, plunger-type terminals are provided for rapid attachment and disconnection of leads. Case is molded synthetic resin. James G. Biddle Co., Philadelphia, Pa.

Non-Slip Powder

"Floorimac A" is composed of crystalline mineral, in powder form, and is intended to be sprinkled on floors that are slippery from the presence of oil, grease, or water, in order to prevent accidents caused by slipping. It is said to be invisible on the floor. Dirsorbene Chemical Corp., 456 Fourth Ave., New York, N. Y.

Conveyor Belt

Called the "Condor." Constructed with an interlaced, cord-duck carcass, and bonded with a special rubber compound which binds the entire structure of the carcass into an inseparable section. Some of the advantages claimed are extreme flexibility, lack of stretch, long life, and puncture-proof qualities. Manhattan Rubber Manufacturing Division of Raybestos-Manhattan, Inc., Passaic, N. J.

Rust-Removing Products

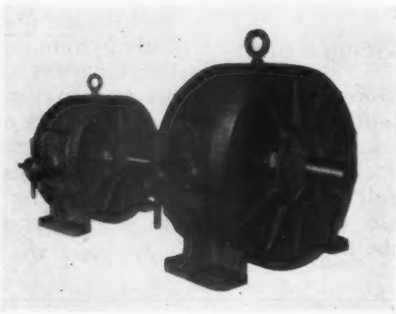
Solvents, in three forms, for removing rust from iron and steel parts. "Beta" Rust Solvent is a non-poisonous liquid used in weak concentrations in hot water. Claimed to remove all traces of oxide without harming the base metal. Beta Strip, in weak, aqueous solutions, removes rust, paint, oil, and grease in one operation. Beta Rust-off Paste is for objects too bulky to be immersed in a tank. It is a thin paste which is painted on a rusty surface, allowed to remain for a few moments, and then scrubbed off with steel wool or a wire brush. Stanford Chemical Co., 112 Bleecker St., New York, N. Y.

Electric Pipe Machine

Another member of the Beaver line of pipe tools. Called the Beaver power adapter. May be operated by any standard electric or air drill. The entire outfit consists of a power adapter, a base, and a set of dieheads from ¼ to 2 in. Used with the average ½-in. "special" electric drill, the unit will thread all sizes of pipe up to 2 in. With the ⅝-in. heavy-duty drill, the unit has sufficient power to drive geared tools for cutting and threading pipe up to 6 in. Operating speed of the diehead under load is from 10 to 15 r.p.m. The unit will cut right- or left-hand threads, and is reversible for backing off. A driving spud to fit all standard drill chucks is furnished with each adapter. The Borden Co., Warren, Ohio.

Hydraulic Pumps

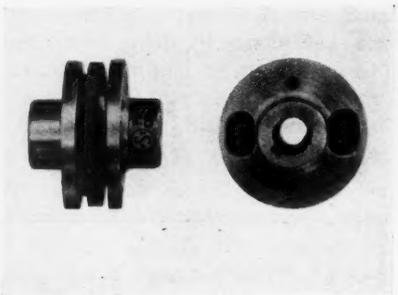
Hydraulic pumps and motors of the rotary, radial piston type, available in sizes from 1 to 200 gal. per min., and pressures up to 4,000 lb. per sq.in. The volume of discharge can be changed to deliver any amount from zero to maximum capacity, and the discharge can be reversed without stopping the pump or changing the speed or rotation. Series 5000 pumps, as the line is called, are



fitted with nitralloy. Hydraulic forces are balanced to prevent heavy bearing loads at high pressures. Available also for use on these pumps is a complete line of automatic controls and semi-automatic valve mechanisms. Northern Pump Co., Minneapolis, Minn.

Flexible Couplings

Called the Small Series. Similar in construction to the larger "Flexoid" line. Flanges are of aluminum alloy. Flange connection is made by socket-head cap screws through specially designed, "Thermoid Hardy," flexible fabric disks in such a manner that there are no metal-to-metal bearing surfaces. Available in two sizes: one having a



diameter of ⅝ in. and capable of transmitting up to 1 hp. at 1,800 r.p.m.; the other a diameter of 3⅛ in., a total hub length of 2⅝ in. and capable of transmitting up to 3 hp. at 1,800 r.p.m. The couplings may be used in either a vertical or horizontal position. The Smith Power Transmission Co., Penton Bldg., Cleveland, Ohio.

Conduit Clamp

An improved conduit and cable clamp with a slot into which a bolt with nut attached can be slipped into place. A bolt the right length is supplied with the clamp, eliminating the necessity for cutting off the end. Suppiied for conduit from ⅜ to 2½ in. The Paine Co., 2951 Carroll Ave., Chicago, Ill.

Metering Unit

A compact, self-contained, metering unit for special application on 120/208-volt, three-phase, four-wire network systems. Inside the cabinet are three

(Continued on advertising page 28)